

# APPENDIX A

## Species Profiles

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## SPECIES PROFILE

# Alewife

*Alosa pseudoharengus*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5

State Rank: S5

Author: Matthew A. Carpenter, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Alewives use various freshwater spawning habitat including riverine oxbows, ponds, and mid-river sites. Juveniles remain in freshwater until late summer and early fall when they migrate into estuaries and eventually to the ocean. When not spawning, adult alewives congregate in areas of the Nantucket Shoals, Georges Bank, and the shores of the Gulf of Maine.

### 1.2 Justification

Dams severely limit accessible anadromous fish spawning habitat, and alewives must use fish ladders for access to spawning habitat during spring spawning runs. River herring are a key component of freshwater, estuarine, and marine food webs (Bigelow and Schroeder 1953). They are an important prey for many predators, and they contribute nutrients to freshwater ecosystems (Macavoy et al. 2000).

### 1.3 Protection and Regulatory Status

The taking of river herring in New Hampshire waters is open only to residents, and no fish may be taken on Wednesdays. A harvest permit is required to take river herring by any form of netting. Herring caught at sea are further regulated, and when the season is closed between 21 September and 19 October, the maximum incidental catch is to 2,000 lbs daily. The

alewife is protected under the Anadromous Fish Conservation Act.

### 1.4 Population and Habitat Distribution

The alewife ranges from Newfoundland to South Carolina. Some populations, such as those in the Great Lakes, are landlocked (Atlantic States Marine Fisheries Commission 1999). In New Hampshire, alewives spawn in the Merrimack River and the sea-coast drainages (Scarola 1987).

### 1.5 Town Distribution Map

*Not completed for this species.*

### 1.6 Habitat Map

Alewives inhabit the lower section of the Merrimack River and the coastal watersheds of New Hampshire. See the Non-Tidal Coastal Watershed, Connecticut River Mainstem Watershed, and Tidal Coastal Watershed profiles.

### 1.7 Sources of Information

Literature reviews and historical records of fish passage at dams in New Hampshire and Massachusetts were used to identify distribution and habitat requirements.

### 1.8 Extent and Quality of Data

River herring are monitored annually at fishways on the Connecticut, Merrimack, and coastal rivers.

### 1.9 Distribution Research

The stream reaches used as spawning habitat by anadromous fish in New Hampshire are relatively unknown. Research in New Hampshire may identify

quality spawning habitat upstream from impassable dams. A GIS map of the stream reaches accessible to anadromous species, combined with a map of potential spawning habitat, would facilitate restoration efforts.

**ELEMENT 2**

*Not completed for this species*

**ELEMENT 3**

*Not completed for this species*

**ELEMENT 4**

*Not completed for this species*

**ELEMENT 5: REFERENCES**

- Atlantic States Marine Fisheries Commission [ASMFC]. 1999. Amendment 1 to the Interstate Management Plan for Shad and River Herring. ASMFC Fishery Management Report No. 35.
- Bigelow H., and W. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bulletin of the Fish and Wildlife Service. No. 74. Vol 53.
- MacAvoy, S.E., S.A. Macko, S.P. McNinch, and G.C. Garman. 2000. Marine nutrient contributions to freshwater apex predators. *Oecologia* 122:568-573.
- Scarola J. 1987. Freshwater Fishes of New Hampshire. New Hampshire Fish and Game Department. 132p.

## SPECIES PROFILE

# American Eel

*Anguilla rostrata*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5

State Rank: S5

Author: Matthew A. Carpenter, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

American eels use marine, estuarine, and freshwater habitat (Atlantic States Marine Fisheries Committee (ASMFC) 2000). American eels breed collectively in the Sargasso Sea, a large area of the western Atlantic Ocean. After hatching, larval eels (leptocephali) drift in ocean currents to the shores of eastern North America, northeastern South America, Europe, and North Africa where they transform into glass eels and then pigmented elvers. Elvers migrate into estuaries and freshwater where they remain for most of their lives. Adults spend 10 to 25+ years in freshwater, where they are referred to as yellow eels. Eventually, yellow eels metamorphose into silver eels that then migrate back to the Sargasso Sea to spawn and die.

### 1.2 Justification

The American eel is in decline throughout its range (Haro et al. 2000), and yellow eel abundance has dropped dramatically in the St. Lawrence River over the past 20 years (Castonguay et al. 1994). Causes of eel declines may include commercial harvest, dams, unfavorable environmental conditions in marine and freshwater environments, pollution, and climate change (Haro et al. 2000). A long life span, combined with extensive migration and a single breeding event, make the American eel population vulnerable to collapse (ASMFC 2000).

### 1.3 Protection and Regulatory Status

In New Hampshire, there is a creel limit of 50 American eels per day, and each must be 6 inches long. American eels may be taken year-round except downstream from a fishway, where they may be taken only from June 15 to October 1. A harvest permit is required if eels are taken by any other method than angling.

### 1.4 Population and Habitat Distribution

The American eel is found in coastal watersheds from northeastern South America to Greenland (ASMFC 2000). In New Hampshire, American eels are found in the seacoast watersheds and portions of the Merrimack and Connecticut River watersheds (Scarola 1987).

### 1.5 Town Distribution Map

*Not completed for this species.*

### 1.6 Habitat Map

American eels inhabit sections of the Merrimack River, Connecticut River, and the coastal watersheds of New Hampshire. See the Non-Tidal Coastal Watersheds (systems 11 and 12), Connecticut River Mainstem Watersheds (systems 1 and 2), Coastal Transitional Watersheds (systems 10 and 14), Northern Upland Watersheds (systems 5 and 7), and Tidal Coastal Watersheds (system 13) profiles.

### 1.7 Sources of Information

Little is known about the distribution of American eels in New Hampshire. Data collected at fish ladders during the spring spawning runs of anadromous fish document the accumulation of elvers below dams at the head of tide on coastal rivers.

## 1.8 Extent and Quality of Data

There has been no comprehensive survey of American eels in New Hampshire waters. Data on American eel distribution are scattered in field notes and records from surveys of other species.

## 1.9 Distribution Research

Due to the rapid decline in recruitment of American eel, priority should be placed on developing or facilitating upstream and downstream passage at dams rather than on establishing the distribution of the species. Distribution research should be linked to evaluations of efforts to improve access to freshwater habitats.

### ELEMENT 2

*Not completed for this species*

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

- Atlantic States Marine Fisheries Commission (ASMFC). 2000. Interstate Fishery Management Plan for American Eel. ASMFC Fishery Management Report No. 36. 79 p.
- Atlantic States Marine Fisheries Commission. 2004. Review of the Atlantic States Marine Fisheries Commission Fishery Management Plan for the American Eel (*Anguilla rostrata*). American Eel Review Team.
- Castonguay, M., P.V. Hodson, C.M. Couillard, M.J. Eckersley, J.D. Dutil, and G. Verreault. 1994. Why is recruitment of the American eel (*Anguilla rostrata*) declining in the St. Lawrence River and Gulf? Canadian Journal of Fisheries and Aquatic Sciences 51:479–488.
- Haro, A., W. Richkus, K. Whalen, A. Hoar, W.D. Busch, S. Lary, T. Brush, and W. Dixon. 2000. Population decline of the American eel: implications for research and management. Fisheries 25: 7–16

Scarola, J. 1987. Freshwater Fishes of New Hampshire (2<sup>nd</sup> Edition). New Hampshire Fish and Game Department. 132p.

## SPECIES PROFILE

# American Shad

*Alosa sapidissima*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5

State Rank: S3

Author: Matthew A. Carpenter, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

American shad are anadromous fish that spawn in moderate to large freshwater rivers along the Atlantic coast. Spawning occurs between 12-20°C and flows of 10-132 cm<sup>2</sup>/sec. The nonadhesive eggs drift in the current until they hatch. Dissolved oxygen levels below 5 mg/l are detrimental to shad at all life stages. In the ocean, shad prefer temperatures between 7-13°C and migrate to deeper water during winter. During summer and fall, shad congregate in the Gulf of Maine and the Bay of Fundy (Bigelow and Schroeder 1953).

### 1.2 Justification

Commercial shad harvests along the U.S. Atlantic coast have declined from an estimated peak of 50,499,000 lbs in 1896 to around 8,134,000 lbs in 1960 (Weiss-Glanz et al. 1986). Catches have continued to decline over the past 40 years due to the cumulative effect of dams, pollution, and over-fishing (Weiss-Glanz et al. 1986). Impassable dams have reduced available river spawning habitat in Maine by 95%, and in New Hampshire dams restrict shad to a fraction of their historical spawning habitat.

### 1.3 Protection and Regulatory Status

In New Hampshire, there is a 2-fish daily limit that must be caught by angling. There are no length or

weight limits. American shad taken by any other method must be released. There is no commercial fishery for American shad in New Hampshire, and incidental catch of shad in other fisheries cannot exceed 5% of the total landing per trip (Atlantic States Marine Fisheries Commission 1999). The American shad is protected under the Anadromous Fish Conservation Act.

### 1.4 Population and Habitat Distribution

American shad spawn in rivers from Florida to Newfoundland, though they are most abundant from Connecticut to North Carolina. They were recently introduced to the Pacific coast. In New Hampshire, the largest historic populations spawned in the Connecticut and Merrimack rivers. The distribution of historical shad spawning areas in the coastal rivers is not well documented.

### 1.5 Town Distribution Map

*Not completed for this species*

### 1.6 Habitat Map

American shad inhabit the lower section of the Merrimack River and the coastal watersheds of New Hampshire. See the Non-Tidal Coastal Watersheds (systems 11 and 12), Mainstem Watersheds (systems 1 and 2), and Tidal Coastal Watersheds (system 13) profiles.

### 1.7 Sources of Information

Literature reviews and historical records of fish passage at dams in New Hampshire and Massachusetts were used to identify distribution and habitat requirements.

## 1.8 Extent and Quality of Data

Shad returns are monitored annually at fishways on the Connecticut, Merrimack, and coastal rivers.

82(11.59). U.S. Army Corps of Engineers, TR EL-82-4. 16 pp.

## 1.9 Distribution Research

Spawning habitats for anadromous fish in New Hampshire are relatively unknown. Research may identify quality spawning habitat upstream from impassable dams. A GIS map of the stream reaches currently accessible to each anadromous species, combined with a map of potential spawning habitat that is inaccessible, would facilitate restoration efforts.

### ELEMENT 2

*Not completed for this species*

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

ASMFC (Atlantic States Marine Fisheries Commission). 1985. Fishery Management Plan for the Anadromous Alosid Stocks of the Eastern United States: American Shad, Hickory Shad, Alewife, and Blueback Herring: Phase II in Interstate Management Planning for Migratory Alosids of the Atlantic Coast. Washington, D.C. XVIII + 347 pp.

ASMFC [Atlantic States Marine Fisheries Commission]. 1999. Amendment 1 to the Interstate Management Plan for Shad & River Herring. ASMFC Fishery Management Report No. 35. 77 p.

Bigelow, H., and W. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bulletin of the Fish and Wildlife Service. 74(53)

United States Fish and Wildlife Service. 2004. Fish Facts- American Shad. Available [http://www.fws.gov/r5crc/Fish/z\\_b\\_alsa.html](http://www.fws.gov/r5crc/Fish/z_b_alsa.html). (Accessed May 2005).

Weiss-Glanz, L.S., J.G. Stanley, and J.R. Moring. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (North Atlantic)--American shad. United States Fish and Wildlife Service Biol. Rep.

## SPECIES PROFILE

# Atlantic Salmon

*Salmo salar*

Federal Listing: Partial Status

State Listing: Not listed

Global Rank: G5

State Rank: S4

Author: Matthew A. Carpenter, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Young Atlantic salmon inhabit cool, swift moving streams with riffles and gravelly cobble substrates. As Atlantic salmon mature, they also use areas of slower moving water with pools and vegetation (DeGraff and Bain 1986). Atlantic salmon spend 2 to 3 years in freshwater before descending to the Atlantic Ocean. At least 1 year is spent feeding in the ocean before returning to spawn. Spawning occurs between October and November in riffle habitats over gravel substrate.

### 1.2 Justification

Atlantic salmon have a complex life cycle, and can be harmed by overharvest, predation, pollution, and impoundments. Atlantic salmon were abundant in pre-colonial times) and were declared extirpated from both the Connecticut and Merrimack rivers in the early nineteenth century. The loss was attributed to the construction of impassable dams (Connecticut River Atlantic Salmon Commission 1998, Merrimack River Policy and Technical Committees 1990).

### 1.3 Protection and Regulatory Status

In the Pemigewasset River and its tributaries, Atlantic salmon cannot be taken upstream of Ayers Island Dam in Bristol. Only tagged Atlantic salmon (brood stock release) can be taken in the Merrimack River

and lower Pemigewasset River. The Connecticut River is closed to taking Atlantic salmon. Sea-run Atlantic salmon may be taken by angling in coastal watersheds. Fish must be at least 15 inches long, and only 2 may be taken daily.

### 1.4 Population and Habitat Distribution

The Atlantic salmon is native to the North Atlantic Ocean. In North America, historical spawning runs of adult Atlantic salmon occurred in rivers from northern Quebec to the Connecticut River (Scott and Crossman 1973). Spawning runs in the Connecticut River watershed included tributaries as far upstream as Beecher Falls in West Stewartstown, New Hampshire (Connecticut River Atlantic Salmon Commission 1998). Spawning adult Atlantic salmon migrated as far upstream as Profile Lake (Franconia, New Hampshire) in the Merrimack River watershed (Greenwood 2005). Salmon restoration projects involve annually stocking of Atlantic salmon of various ages as far upstream as the Mohawk River in Colebrook (Connecticut River watershed) and the headwaters of the Pemigewasset River in Franconia (Merrimack River watershed) (Dianne Emerson, New Hampshire Fish and Game (NHFG), personal communication and Jon Greenwood, NHFG, personal communication).

### 1.5 Town Distribution Map

*Not completed for this species*

### 1.6 Habitat Map

Atlantic salmon populations were historically scattered throughout Merrimack, Connecticut, and coastal watersheds of New Hampshire. See the Northern Upland Watersheds (refer to the systems 5 and 7), Mainstem Watersheds (systems 1 and 2), Southern Upland Watersheds (systems 3 and 9),

Montane Watersheds (systems 4, 6, and 8), Coastal Transitional Watersheds (systems 10 and 14), and Non-Tidal Coastal Watersheds (systems 11 and 12) profiles.

### 1.7 Sources of Information

Published literature, a recovery plan for Atlantic salmon, and consultations with fisheries biologists were used to determine distribution and habitat requirements of the species.

### 1.8 Extent and Quality of Data

The abundance and extent of Atlantic salmon spawning migrations in pre-colonial times is speculative, and it is possible that spawning runs were exaggerated. During these times, fishery science techniques to quantify fish abundances were not available (Connecticut River Atlantic Salmon Commission 1998). Selected rivers and streams that receive stocked Atlantic salmon have been identified and are annually monitored.

### 1.9 Distribution Research

Rivers and streams that receive stocked Atlantic salmon are well known and monitored.

#### ELEMENT 2

*Not completed for this species*

#### ELEMENT 3

*Not completed for this species*

#### ELEMENT 4

*Not completed for this species*

#### ELEMENT 5: REFERENCES

- Connecticut River Atlantic Salmon Commission. 1998. Strategic Plan for the Restoration of Atlantic Salmon to the Connecticut River. 109p.
- DeGraff, D., and L. Bain. 1986. Habitat use by and preference of juvenile Atlantic salmon in two Newfoundland rivers. Transactions of the American Fisheries Society. 115:671-681.
- Greenwood J. 2005. Anadromous Fisheries in New Hampshire. <http://www.wildlife.state.nh.us/>

[Fishing/fisheries\\_management/anadromous.htm](http://www.wildlife.state.nh.us/Fishing/fisheries_management/anadromous.htm)>. Accessed 2005.

Merrimack River Policy and Technical Committees. 1990. Strategic Plan for the Restoration of Atlantic Salmon to the Merrimack River 1990 through 2004. 56p.

Scott, W., and E. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada. 966p.

## SPECIES PROFILE

# Atlantic Sturgeon

*Acipenser oxyrinchus*

Federal Listing: N3  
State Listing: Not listed  
Global Rank: G3  
State Rank: S1  
Author: Benjamin J. Nugent, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

The Atlantic Sturgeon is anadromous, living in marine waters and entering fresh and brackish waters during spawning migrations. Spawning runs are from February to July depending on the location of the river (Scott and Crossman 1973). In Maine, spawning occurs in July. Migration activity during spawning periods has been observed at depths of 10 to 42 feet and temperatures of 13.3° to 18.4°C (Scott and Crossman 1973, Everhart 1976, Kieffer and Kynard 1993). The return migration of spent adults to marine waters appears to be somewhat random, and the highest concentrations of adults return between September and November (Scott and Crossman 1973). Spawning substrates consist of hard clay, small rubble, and gravel (Everhart 1976). Eggs are adhesive when dispensed, attaching to vegetation and stones. Juveniles will spend up to 4 years in riverine or tidal habitats (Scott and Crossman 1973).

### 1.2 Justification

Over-harvest, habitat degradation, and barriers all contributed to the population declines that were first noticed at the beginning of the twentieth century (Smith 1995). More studies of Atlantic sturgeon in New Hampshire are needed.

### 1.3 Protection and Regulatory Status

Participating states of the Atlantic States Marine Fisheries Commission's Interstate Fishery Management Plan have prohibited fishing for Atlantic sturgeon. The Atlantic sturgeon was a candidate species for the endangered or threatened species list (1988 and 1998) but was later denied. The possession of sturgeon is prohibited in New Hampshire.

### 1.4 Population and Habitat Distribution

Evidence from colonial times suggests that the species existed in the Connecticut, Merrimack, and Coastal watersheds, though little is known about the extent of the species' range in these watersheds (Kieffer and Kynard 1993). Amoskeag Falls (Manchester, New Hampshire) is believed to have been the historical limit for Atlantic sturgeon in the Merrimack River. Currently, the species is believed not to exist in the Connecticut and Merrimack watersheds within New Hampshire. Two Atlantic Sturgeon have been found upstream of the Great Bay Estuary System since 1981 (Doug Grout, NHFG, personal communication). The Great Bay area is potentially used by sub adults (younger than 2) for nursery habitat, though it is not believed that spawning occurs in the bay (NMFS 1998).

### 1.5 Town Distribution Map

*Not completed for this species.*

### 1.6 Habitat Map

Atlantic sturgeon historically inhabited the lower sections of the Connecticut and Merrimack rivers and the coastal watershed of New Hampshire. See the Lower Connecticut (systems 1 and 2), Lower Merrimack (systems 11 and 12), and Coastal Rivers (system 13) watershed profiles.

## 1.7 Sources of Information

Published literature was used to define habitat characteristics and historical distribution. Fisheries professionals provided additional information on recent sightings.

## 1.8 Extent and Quality of Data

Atlantic sturgeon cannot reach historic spawning areas in the Connecticut and Merrimack watersheds (Micah Kieffer, United States Geological Survey (USGS), personal communication), and only 2 recent (1981 and 1991) observations of the species have occurred in the coastal waters of New Hampshire. A monitoring project for shortnose sturgeon (*Acipenser brevirostrum*) from 1987 to 1988 lacked any incidental catches of Atlantic Sturgeon (NHFG unpublished data).

## 1.9 Distribution Research

Habitat assessments of coastal watersheds may reveal areas of potential Atlantic sturgeon spawning habitat. Results from these habitat assessments may identify barriers and other factors that prevent the species from reaching preferred spawning grounds.

### ELEMENT 2

*Not completed for this species*

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

Everhart W. 1976. Fishes of Maine. Maine Department of Inland Fisheries and Wildlife. 96p.

Kieffer, M., and B. Kynard. 1993. Annual Movements of Shortnose and Atlantic Sturgeons in the Merrimack River, Massachusetts. Transactions of the American Fisheries Society 122:1088-1103.

National Marine Fisheries Service (NMFS). 1998. Status Review of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*). United States Department of Commerce, National Oceanic and Atmospheric

Administration, National Marine Fisheries Service.

Smith T. 1995. The Fishery, Biology, and management of Atlantic Sturgeon, *Acipenser oxyrinchus*, in North America. Environmental Biology of Fishes 14:61-72.

## SPECIES PROFILE

# Banded Sunfish

*Enneacanthus obesus*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5

State Rank: S3

Author: Matthew, A. Carpenter, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Banded sunfish prefer vegetated areas of ponds, lakes, and the backwaters of lowland streams (Scarola 1987). Banded sunfish are highly tolerant of acidic water and can withstand pH levels as low as 4.0 (Gonzales and Dunson 1989). Tolerance for acidic water may be an adaptation that provides banded sunfish with access to habitats unavailable to other fish species (Graham and Hastings 1984, Gonzales and Dunson 1991) and may provide the banded sunfish with refuge from both native and introduced species of predaceous fish (Graham 1993).

### 1.2 Justification

Little is known about the ecology or distribution of the banded sunfish in New Hampshire. Most records are from the southeastern part of the state where human populations are rapidly increasing. Of 37 known records, 16 were collected in a statewide biological inventory conducted in the late 1930s by NHFG (Gordon 1937, Bailey 1938, Bailey and Oliver 1939).

### 1.3 Protection and Regulatory Status

Banded sunfish may not be used as bait in New Hampshire.

### 1.4 Population and Habitat Distribution

Banded sunfish inhabit the Atlantic coastal plain from southern New Hampshire to Florida (Scarola 1987). In New Hampshire they are found in lowland areas of the Merrimac River and in coastal watersheds (Scarola 1987). A population has also been documented in the upper Millers River system, which drains into the Connecticut River (Bailey and Oliver 1939). Though populations may be locally abundant, they are not widely distributed.

### 1.5 Town Distribution Map

Before 20 years ago, banded sunfish occurred in the towns of Hudson, Manchester, Merrimack, Nashua, New Ipswich, Nottingham, Pelham, Rindge, Salem, South Hampton, and Windham. Within the last 20 years, sightings have occurred in Amherst, Bedford, Brookline, East Barrington, Hampton, Hollis, Lee, Londonderry, Madbury, Manchester, Merrimack, Milford, New Ipswich, North Hampton, Peterborough, and Rindge.

### 1.6 Habitat Map

More research will be necessary to determine the current distribution and habitat requirements of this species in New Hampshire. A map of low-gradient streams and pond habitat in the coastal watersheds (refer to system 13), the Merrimac watersheds (refer to system 11 and system 12), and the Millers River watershed in the Connecticut River drainage (refer to system 9), would facilitate future surveys.

### 1.7 Sources of Information

Records of banded sunfish came from Biological Surveys by NHFG from 1937 to 1939, NHFG) Fishing

For the Future project, the Environmental Protection Agency EMAP pilot fish sampling summary from the Northeast Lakes Monitoring Project, the New Hampshire Department of Environmental Services Biomonitoring Program, and reports from independent biologists.

### 1.8 Extent and Quality of Data

Records of banded sunfish were gathered from federal, state, and private monitoring projects. The distribution of the species cannot be established with available data because none of these projects specifically targeted banded sunfish or their habitat. Available records may be used to guide future surveys of the banded sunfish in New Hampshire.

### 1.9 Distribution Research

Survey work from the 1930s and the NHFG Fishing for the Future project provide evidence for the presence of banded sunfish in certain water bodies. The first priority should be to check for the presence of the species at sites with historic records. Once historical records are verified, a more conclusive statewide distribution of the species can be established by sampling waters in close proximity to known populations.

Studies of the factors that limit the distribution and abundance of banded sunfish will likewise be helpful. Data collected from sites with known populations may be used to recommend new survey sites. Data should be entered into a GIS database to help identify variables that may predict the presence of banded sunfish and to track the distribution of the species over time.

#### ELEMENT 2

*Not completed for this species*

#### ELEMENT 3

*Not completed for this species*

#### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

### 5.1 Literature

- Bailey J.R., and J.A. Oliver. 1939. The fishes of the Connecticut watershed. In: A biological survey of the Connecticut watershed. New Hampshire Fish and Game Dept., Survey Report No. 4:150-189.
- Bailey, R.M. 1938. The fishes of the Merrimack watershed. In: A biological survey of the Merrimack watershed. New Hampshire Fish and Game Department Survey Report No. 3:149-185.
- Gonzales, R.J., and W.A. Dunson. 1989. Differences in low pH tolerance among closely related sunfish of the genus *Enneacanthus*. *Environmental Biology of Fishes* 26(4):303-310.
- Gonzales, R.J., and W.A. Dunson. 1991. Does water pH control habitat segregation of sibling species of sunfish *Enneacanthus*? *Wetlands* 11(2):313-324.
- Gordon, M. 1937. The fishes of eastern New Hampshire. In: A biological survey of the Androscoggin, Saco, and Coastal watersheds. New Hampshire Fish and Game Department, Survey Report No. 2:101-118.
- Graham, J.H., and R.W. Hastings. 1984. Distributional patterns of sunfishes on the New Jersey coastal plain. *Environmental Biology of Fishes* 10: 137-148.
- Graham, J.H. 1993. Species diversity of fishes in Naturally acidic lakes in New Jersey. *American Fisheries Society*. 122:1043-1057.
- Scarola J. 1987. *Freshwater Fishes of New Hampshire*. New Hampshire Fish and Game Department, Concord, New Hampshire, USA.

### 5.2 Data Sources

- Biomonitoring Program. 1995-2005. New Hampshire Department of Environmental Services, Watershed Management Bureau. [www.des.state.nh.us/wmb/biomonitoring/sites/index.html](http://www.des.state.nh.us/wmb/biomonitoring/sites/index.html) >. Accessed 2004 December 12

## SPECIES PROFILE

# Blueback Herring

*Pomolobus aestivalis*

Federal Listing: Not listed

State Listing: Not listed

Affected Species: Not listed

Global Rank: G5

State Rank: S4

Author: Matthew A. Carpenter, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Blueback herring are anadromous fish that spawn over various substrata in fast and slow rivers and streams (United States Fish and Wildlife Service 2001). Adults return to the ocean after spawning, and young of the year migrate to the ocean by autumn. Little is known about ocean movements, but both blueback herring and alewives (*Pomolobus pseudoharengus*) have been known to congregate on Georges Bank, the Nantucket Shoals, and the perimeter of the Gulf of Maine during the fall (Bigelow and Schroeder 1953).

### 1.2 Justification

Dams severely limit accessible spawning habitat, and river herring (alewives and blueback herring) depend on fish ladders to ascend dams and reach spawning habitat. River herring are a key component of freshwater, estuarine, and marine food webs. They are an important prey item of many marine predators and they contribute nutrients to freshwater ecosystems (Durbin et al. 1979, Macavoy et al. 2000).

### 1.3 Protection and Regulatory Status

The taking of river herring is open only to New Hampshire residents, and no fish may be taken by any method on Wednesdays. A harvest permit is re-

quired to take river herring by any form of netting. Herring caught at sea are further regulated, and between September 21 and October 19, the maximum incidental catch is limited to 2000 lbs per day. The blueback herring is protected under the Anadromous Fish Conservation Act.

### 1.4 Population and Habitat Distribution

The blueback herring is found along the Atlantic coastal plain from Florida to Nova Scotia (Atlantic States Marine Fisheries Commission 1999). In New Hampshire the blueback herring spawning runs occur in the Connecticut River, the Merrimack River, and the seacoast drainages (New Hampshire Fish and Game 2004, Greenwood 2005).

### 1.5 Town Distribution Map

*Not completed for this species*

### 1.6 Habitat Map

Blueback herring inhabit the lower section of the Merrimack River and the coastal watersheds of New Hampshire. See the Non-Tidal Coastal Watersheds (systems 11 and 12), Mainstem Watersheds (systems 1 and 2), and Tidal Coastal Watersheds (system 13) profiles.

### 1.7 Sources of Information

Literature reviews and historical records of fish passage at dams in New Hampshire and Massachusetts were used to identify distribution and habitat requirements.

### 1.8 Extent and Quality of Data

River herring returns are monitored at fishways on the Connecticut, Merrimack, and coastal rivers.

## 1.9 Distribution Research

Spawning habitats for New Hampshire's anadromous fish are relatively unknown. Research may identify quality spawning habitat upstream of impassable dams. A GIS map of the stream reaches accessible to each anadromous species, combined with a map of the potential spawning habitat that is currently inaccessible, would facilitate restoration.

### ELEMENT 2

*Not completed for this species*

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

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## SPECIES PROFILE

# Bridle Shiner

*Notropis bifrenatus*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G3

State Rank: S3

Author: Matthew, A. Carpenter, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Bridle shiners inhabit backwater streams and ponds with little or no current (Harrington 1948b; Finger 2001). They feed and spawn among submerged and emergent vegetation in shallow water (Harrington 1948a; Harrington 1948b).

### 1.2 Justification

The bridle shiner is declining over most of its range (Sabo 2000). In Pennsylvania, where the bridle shiner is listed as endangered, its range has been reduced to 1 site out of 31 historical sites (Finger 2001). Although the reasons for the decline of the bridle shiner are poorly understood, the long-term effects of urbanization, such as increased turbidity and changes in hydrology, have been attributed to the decline of other cyprinids (Weaver and Garman 1994, Fairchild et al. 1997). The range of the bridle shiner in New Hampshire is almost entirely in the southeast, an area undergoing the fastest rate of urbanization in New England.

### 1.3 Protection and Regulatory Status

The bridle shiner is listed as a legal bait species in New Hampshire.

### 1.4 Population and Habitat Distribution

The bridle shiner was once widely distributed throughout the Atlantic coastal plain from North Carolina north to the St. Lawrence River and eastern Ontario (Scott and Crossman 1973). Records of the bridle shiner in New Hampshire are limited to the Merrimack and coastal watersheds. The current distribution of the bridle shiner in New Hampshire is not well known.

### 1.5 Town Distribution Map

Canterbury, Concord, Conway, Durham, Eaton, Epping, Epsom, Farmington, Freedom, Hillsborough, Hooksett, Lee, Loudon, Madison, Meredith, Merrimack, Middleton, Milton, Moultonborough, New Hampton, Nottingham, Northwood, Pittsfield, Rochester, Salem, Sanborton, South Hampton, Strafford, Webster, Windham

### 1.6 Habitat Map

More research is necessary to determine the distribution and habitat requirements of this species in New Hampshire. A map of low-gradient streams and pond habitat in the coastal watersheds (refer to the system 13) and the Merrimack watersheds (systems 10, 11, 12, and 14) would help target future survey work.

### 1.7 Sources of Information

Bridle shiners have been caught during the Fishing for the Future Project conducted by New Hampshire Fish and Game (NHFG) and the Biomonitoring Program of the New Hampshire Department of Environmental Services. Historical records are from biological surveys conducted by the NHFG from 1937 to 1939.

## 1.8 Extent and Quality of Data

Twenty-nine of 49 records come from biological surveys by NHFG in the 1930s. No surveys have specifically targeted bridled shiners or their habitat in New Hampshire. A systematic survey will be necessary to establish the range of the species in the state.

## 1.9 Distribution Research

Habitat studies are needed to better understand the potential distribution of bridled shiners in New Hampshire. Resurveying historical sampling sites may show changes in the range of this species. All data on the distribution of bridled shiner, as well as other fish species native to New Hampshire, should be consolidated into a central database.

The bridled shiner is one of 4 fish species of concern—including redbfin pickerel, banded sunfish, and swamp darter—that depend on vegetated stream and pond habitats of southeastern New Hampshire. The ecology of this aquatic system is poorly understood. Fish surveys in these habitats can be used as a baseline for monitoring the effects of urbanization and for measuring the success of future restoration or protection efforts.

### ELEMENT 2

*Not completed for this species*

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

### 5.1 Literature

Bailey, R.M. 1938. The fishes of the Merrimack watershed. In: A biological survey of the Merrimack watershed. New Hampshire Fish and Game Dept., Survey Report No. 3:149-185

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### 5.2 Data Sources

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NatureServe. 2005. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.2. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: February 2, 2005).

## SPECIES PROFILE

# American Brook Lamprey

*Lampetra appendix*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G4

State Rank: S2

Author: Matthew, A. Carpenter, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

The American brook lamprey lives in cool freshwater streams and small rivers. Adults spawn at the head of riffle areas over coarse sand and gravel substrate with stones less than 7 cm wide (Mundahl 1996). Spawning adults construct small nests by moving stones with their disc-shaped mouths (Hoff 1988). After hatching, larvae (ammocoetes) drift downstream to areas of slower flow where they burrow into the sediment and filter feed on organic detritus for about 5 years (Beamish and Lowartz 1996). Ammocoetes prefer to burrow in medium to fine grained sand mixed with organic matter (Beamish and Lowartz 1996).

### 1.2 Justification

The American brook lamprey has a complex life cycle that depends on 2 specific habitat types within a stream. Alteration or fragmentation of one or both of these habitats could result in local extirpations of brook lamprey populations. The presence of the American brook lamprey has been recorded in only 2 streams in New Hampshire. The species has not been monitored since it was last observed in the late 1980s.

### 1.3 Protection and Regulatory Status

The American brook lamprey is not specifically regulated, but is indirectly affected by regulations covered

under the Southern Upland Watersheds and the Non-Tidal Coastal Watersheds profiles..

### 1.4 Population and Habitat Distribution

The American brook lamprey is found in rivers along the Atlantic coast from North Carolina to New Hampshire and throughout the Great Lakes drainages (Scott and Crossman 1973). In New Hampshire, where the species reaches the northern extent of its coastal range, records are restricted to 2 river systems: Baboosic Brook in the Merrimack River watershed and the Oyster River in the Great Bay watershed. No surveys of American brook lamprey have been conducted in New Hampshire.

### 1.5 Town Distribution Map

In the last 20 years, American brook lamprey have been observed in Lee and Merrimack; earlier sightings were limited to Durham.

### 1.6 Habitat Map

More research will be necessary to determine the current distribution and habitat requirements of this species in New Hampshire. Within the coastal watersheds (refer to the system 13) and the Merrimack watersheds (refer to systems 10, 11, and 12), a map of low gradient streams with access to riffle and pools habitat upstream would facilitate future surveys.

### 1.7 Sources of Information

Records of the American brook lamprey in New Hampshire are from 2 sources: Sampling data from the Fishing for the Future Project conducted by New Hampshire Fish and Game (NHFG) and collections by Dr. Phil Sawyer, a zoology professor at the Univer-

sity of New Hampshire (NHFG unpublished data, Sawyer 1960). All records have been compiled into a database maintained by NHNHBB.

### 1.8 Extent and Quality of Data

The Fishing for the Future project was initiated in 1983 with the recognition of a need to base fish stocking efforts on more quantifiable measures of stream characteristics (NHFG unpublished data). Data on the physical and biological characteristics of streams were collected at over 264 sites throughout New Hampshire (NHFG unpublished data). The sampling data are of high quality, but the sampling sites were chosen based on known salmonid stocking locations and did not represent the full diversity of New Hampshire stream habitat. Therefore the American brook lamprey may be more widespread in New Hampshire than current records indicate. There is historical evidence of an American brook lamprey population in the Oyster River (Sawyer 1960).

### 1.9 Distribution Research

In New Hampshire, initial surveys should focus on the 2 streams with records of the species, after which data collected at confirmed spawning areas could be used to identify potential spawning areas in other streams. The locations of known and potential spawning sites should be entered into a GIS database as part of a larger effort to record the distribution of native fish species and their habitats in New Hampshire.

Once the distribution of the American brook lamprey in New Hampshire is better understood, certain spawning sites may be selected for long term monitoring.

Surveys of spawning adult American brook lampreys have been used to establish the distribution of the species in Minnesota (Mundahl 1996). Modified fyke nets have also been used to capture lampreys as they migrate upstream to spawning areas (Harvey and Cowx 2000). In addition, electrofishing surveys downstream of known spawning areas may identify stream reaches with a high density of ammocoetes (Beamish and Lowartz 1996). Conservation strategies for protecting the American brook lamprey population in New Hampshire will be developed after the population and status of the species have been established.

#### ELEMENT 2

*Not completed for this species*

#### ELEMENT 3

*Not completed for this species*

#### ELEMENT 4

*Not completed for this species*

#### ELEMENT 5: REFERENCES

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## SPECIES PROFILE

# Brook Trout

*Salvelinus fontinalis*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5

State Rank: S5

Author: Matthew A. Carpenter, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Brook trout can survive in almost any clean, cold, well-oxygenated aquatic habitat, though they are unable to tolerate prolonged periods of water temperature over 20°C (Scarola 1987). In areas of swift flow, brook trout prefer the shelter of pools created by boulders and woody debris (Curry et al. 2002). Brook trout spawn over gravel substrate in spring-fed headwater tributaries and along lakeshores with upwelling groundwater (Scarola 1973, Quinn 1995).

### 1.2 Justification

Records suggest that brook trout were once far more abundant in New Hampshire than they are today (Noon 2003), and their popularity among anglers has resulted in a long history of government stocking programs (Noon 2003). For over 100 years, New Hampshire Fish and Game (NHFG) has augmented native brook trout populations with fish raised in hatcheries (NHFG unpublished data). Wild brook trout may develop unique adaptations to local conditions over time, and the continuous introduction of hatchery-raised brook trout can wipe out these local adaptations (Hayes et al. 1996). There has been recent interest in identifying and protecting native strains of brook trout that have not experienced genetic introgression by hatchery-raised fish (Trout Unlimited 2003-2004).

### 1.3 Protection and Regulatory Status

Though there is no size limit or closed season, there is a daily limit of 5 fish or 5 pounds (2 fish through ice) when taking brook trout from a lake or pond. The same rules apply to taking brook trout from rivers and streams except that no fish may be taken from 16 October to 31 December. However, many water bodies managed for trout have site-specific rules that further limit the take of fish or the type of gear that can be used.

### 1.4 Population and Habitat Distribution

Brook trout are found in cold-water habitat throughout New Hampshire. The species is native to eastern North America, although it has been introduced into most western states (NatureServe 2005). The natural range of the brook trout includes the southern Appalachians, the upper Mississippi, and Great Lakes drainages, all of the northeastern United States, and eastern Canada (Scarola 1987). Some remote streams in the White Mountains and northern New Hampshire may contain wild brook trout populations that have never mixed with hatchery-raised trout (Scott Decker, NHFG biologist, personal communication).

### 1.5 Town Distribution Map

Brook trout are found throughout New Hampshire, though the locations of native populations are unknown.

### 1.6 Habitat Map

Future research will be necessary to map the locations of native brook trout populations (see Conservation Actions).

## 1.7 Sources of Information

Published literature and NHFG unpublished data.

## 1.8 Extent and Quality of Data

The distribution of native strains of brook trout in New Hampshire is not well documented. Many sites are stocked with brook trout and periodically surveyed by the NHFG. Recently a distinction has been made between “wild trout” populations that reproduce naturally and populations that would decline if no longer stocked. Wild trout populations are carefully monitored to ensure that they remain healthy enough to support angling pressure without the addition of cultured fish.

## 1.9 Distribution Research

Federal, state, and non-government agencies are collaborating on the Eastern Brook Trout Joint Venture, a project designed to assess the status of brook trout populations throughout the eastern United States (Mark Hudy, United States Department of Agriculture Forest Service, unpublished proposal). The project will compile a variety of brook trout related data into a GIS database based on USGS sixth level Hydrological Unit (HU) watersheds. Locally, NHFG will continue its efforts to identify and monitor naturally reproducing trout populations. A further distinction should be made between locations with a history of brook trout stocking and isolated locations where brook trout populations may never have mixed with cultured fish.

### ELEMENT 2

*Not completed for this species*

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

### 5.1 Literature

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### 5.2 Data Sources

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## SPECIES PROFILE

# Burbot

*Lota lota*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5

State Rank: S5

Author: Benjamin, J. Nugent, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Burbot are found in rivers and lakes. They prefer deep, large lakes (Scarola 1987) and are commonly found in the littoral zone during winter. During the summer, burbot are thermally restricted to the profundal zone, and may make night migrations to the littoral zone (Hoffman and Fischer 2002). In rivers, burbot prefer areas with woody debris, vegetation, pools, rocky riffles, and cool temperatures (Paulsen and Hatch 2002). Nighttime spawning occurs in February at shallow depths over sand or gravel substrates (Scott and Crossman 1973, Roy 2001).

### 1.2 Justification

Burbot are one of a few self-sustaining native species targeted by anglers in New Hampshire. However, due to the small size of individuals encountered in lotic environments, the majority of harvest occurs in large lakes (John Viar, New Hampshire Fish and Game (NHFG), personal communication). The species was tied with brook trout (fourth) during a survey of angler preference during the ice-fishing season (Duda and Young 1996). Lake populations of burbot are restricted to a small number of water bodies.

Anthropogenic eutrophication limits dissolved oxygen at depth, where burbot seek thermal refuge during summer. Therefore, the species may be an indicator for the condition of oligotrophic lakes (Kelso

et al. 1996). Lotic populations also appear to be isolated to particular rivers or streams. The degradation of these habitats may be detrimental to the survival of the species.

### 1.3 Protection and Regulatory Status

The burbot is a game fish and may be harvested from lakes and rivers. No regulations limit weight, length, or number of burbot taken. "Set lines" (up to 6) may be used to harvest burbot during the ice-fishing season on lakes. In rivers, open season lasts from 1 January to 15 October.

### 1.4 Population and Habitat Distribution

Burbot populations are found in almost all suitable habitats in the northern part of North America (Scott and Crossman 1973), and have been reported in all major watersheds (Connecticut, Androscoggin, Merrimack, and Coastal) in New Hampshire (Gordon 1937, Bailey 1938, Bailey and Oliver 1939). Although burbot have been sampled in rivers throughout the state, sampling data indicate that riverine populations are more prevalent in northern New Hampshire. There appears to be no clear distribution of populations found in lake habitats (NHFG unpublished data). Known populations exist in several large lakes in central and northern New Hampshire (Bailey and Oliver 1939, Don Miller, NHFG, personal communication).

### 1.5 Town Distribution Map

### 1.6 Habitat Map

The burbot inhabit cold lakes and rivers in several areas of the state. See Habitat Maps for Connecticut and Androscoggin Headwaters (systems 5 and 7),

Lakes Region (systems 10 and 14), Western Hills (systems 3 and 9), Coastal (system 13), and Lower Merrimack (systems 11 and 12).

### 1.7 Sources of Information

Peer-reviewed literature was used for defining the global distribution and habitat requirements of burbot. NHFG unpublished data, NHFG biological surveys (1937-1939), New Hampshire Department of Environmental Services (NHDES) biomonitoring data, and a fisheries biologist helped define the New Hampshire range.

### 1.8 Extent and Quality of Data

Most information on burbot distribution in New Hampshire is from creel surveys and projects related to trout and salmon management (e.g., stream electrofishing surveys). The NHDES Biomonitoring project provides an up-to-date source for the presence of burbot in certain streams.

### 1.9 Distribution Research

Burbot have received less research attention than other game fish in New Hampshire. Although the population is considered stable enough to sustain a fishery, there has been no direct investigation of the burbot population in the state.

Sampling of burbot is difficult in deepwater lakes (Halliwell et al. 2001). The most effective way to track the distribution of burbot would be to enter existing burbot records into a centralized GIS database. This database would form the framework of a more thorough assessment of the burbot population status in New Hampshire. Better record keeping on NHFG surveys that target trout and salmon would increase the amount of data on lakes and streams that are occupied by burbot. Research on burbot ecology and habitat requirements would help identify potential burbot populations in water bodies with less fishing or sampling effort.

#### ELEMENT 2

*Not completed for this species*

#### ELEMENT 3

*Not completed for this species*

#### ELEMENT 4

*Not completed for this species*

### ELEMENT 5: REFERENCES

#### 5.1 Literature

- Bailey J., and J. Oliver. 1939. The Fishes of the Connecticut Watershed. In: A Biological Survey of the Connecticut Watershed. New Hampshire Fish and Game Dept., Survey Report No. 4:150-189.
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- Scarola J. 1987. Freshwater Fishes of New Hampshire. New Hampshire Fish and Game Department, Concord, New Hampshire, USA.
- Scott W., and E. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada. 966p.

#### 5.2 Data Sources

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Paulsen N. and Hatch J. 2002. Burbot *Lota lota* (Linnaeus, 1758) Member of the Cuskfish Family (Lotidae) <<http://www.gen.umn.edu/research/fish/fishes/burbot.html>>. Accessed 2005.

## SPECIES PROFILE

# Finescale Dace

*Phoxinus neogaeus*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5

State Rank: S2

Author: Benjamin, J. Nugent, NHFG

### ELEMENT 1: DISTRIBUTION AND HABITAT

#### 1.1 Habitat Description

Finescale dace inhabit ponds, streams, and lakes with cool temperatures (Scott and Crossman 1973) and have been found to concentrate in areas with silt and large woody debris (Isaak et al. 2002). The species has an affinity for beaver ponds and is often found with northern redbelly dace (*Phoxinus eos*) (Paulsen and Hatch 2002). Finescale dace have been found in stained boggy ponds with neutral or slightly acidic (7.0-6.9) pH (Scott and Crossman 1973). Spawning occurs under logs and other debris between April and June (NatureServe 2005).

#### 1.2 Justification

The species is considered imperiled in New Hampshire (NatureServe 2005) and appears to be isolated to specific waters in the far north. Contemporary data regarding the species within New Hampshire are extremely limited and may indicate low population levels. Habitat degradation and introduction of non-native piscivorous (e.g., sunfish, black bass) fish have seriously harmed finescale dace populations (Isaak et al. 2002).

#### 1.3 Protection and Regulatory Status

Finescale dace may not be used for bait.

#### 1.4 Population and Habitat Distribution

Finescale dace in New Hampshire are at the southeastern corner of the species' global range (Scarola 1987), and they occur in the extreme northern section of the state. Within this region, finescale dace populations are relatively isolated (Bailey and Oliver 1939, Gordon 1937, New Hampshire Fish and Game (NHFG) unpublished data). No populations have been confirmed south of the White Mountains.

#### 1.5 Town Distribution Map

Within the last 20 years, finescale dace have been observed in Clarksville and Pittsburg; before then, dace were observed in Millsfield and Wentworth.

#### 1.6 Habitat Map

More research will be necessary to determine the current distribution and habitat requirements of this species in New Hampshire. A map of pond, stream, and lake habitat in the Connecticut and Androscoggin Headwaters (refer to the systems 5 and 7) would facilitate future surveys.

#### 1.7 Sources of Information

Published literature and Internet sources were used to define the species global distribution and habitat descriptions. NHFG unpublished data and historical biological surveys provided locations of finescale dace in New Hampshire.

#### 1.8 Extent and Quality of Data

Data are qualitative and are too few to identify population trends, though some information dates to the 1930s and 1950s. Data should be treated cau-

tiously, for the northern redbelly dace is very similar in appearance to the finescale dace (Dianne Emerson, NHFG, personal communication).

### 1.9 Distribution Research

Distribution data for finescale dace in New Hampshire are needed. Resurveying historical sample sites may reveal changes in distribution that have occurred since past surveys (recognizing limitations stated in section 1.8). Surveying additional waters in the Androscoggin and upper Connecticut watersheds would provide more conclusive information on the statewide distribution of the species. Studies of factors that limit the distribution and abundance of the species would also aid in identifying potential survey sites.

Hybrids of finescale dace and northern redbelly dace have been found in New Hampshire (Bailey and Oliver 1939, Goddard et al. 1998), warranting a study of the effects of hybridization on the distribution and abundance of the 2 species. A better effort should be made to record observations of finescale dace, as well as other nongame fish, during surveys that target other species. Records of finescale dace should be entered into a GIS database as part of an effort to track the distribution and status of all New Hampshire fish species.

#### ELEMENT 2

*Not completed for this species*

#### ELEMENT 3

*Not completed for this species*

#### ELEMENT 4

*Not completed for this species*

### ELEMENT 5: REFERENCES

#### 5.1 Literature

Bailey, J., and J. Oliver. 1939. The Fishes of the Connecticut Watershed. In: A Biological Survey of the Connecticut Watershed. New Hampshire Fish and Game Dept., Survey Report No. 4:150-189.

Goddard, K., O. Megwinoff, L. Wessner, and F. Giaimo. 1998. Confirmation of gynogenesis in *Phoxinus eos-neogaeus* (Pisces: Cyprinidae). *Journal*

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Gordon, M. 1937. The fishes of eastern New Hampshire. In: A biological survey of the Androscoggin, Saco, and Coastal watersheds. New Hampshire Fish and Game Dept., Survey Report No. 2:101-118.

Isaak, D., W. Hubert, and C. Berry. 2002. Conservation Assessment for Lake Chub, Mountain Sucker, and Finescale Dace in the Black Hills National Forest, South Dakota and Wyoming. Black Hills National Forest, Custer, South Dakota, USA.

Scarola J. 1987. Freshwater Fishes of New Hampshire. New Hampshire Fish and Game Department, Concord, New Hampshire, USA.

Scott, W., and E. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada. 966p.

#### 5.2 Data Sources

Biomonitoring Program. 1995-2005. New Hampshire Department of Environmental Services, Watershed Management Bureau. [www.des.state.nh.us/wmb/biomonitoring/sites/index.html](http://www.des.state.nh.us/wmb/biomonitoring/sites/index.html). Accessed 2004 December 12

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## SPECIES PROFILE

# Lake Trout

*Salvelinus namaycush*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5

State Rank: S5

Author: Benjamin, J. Nugent, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Lake trout inhabit lakes with large reservoirs of deep water, rocky shorelines, and diversely contoured bottoms. During the summer lake trout are restricted to thermal refuges below 60-65°F with preferred water temperatures around 50°F. The species will frequent surface waters in the spring, fall, and winter if temperature permits. Dissolved oxygen levels must exceed 6 parts per million (Scarola 1987, Scott and Crossman 1973, Johnson 2001). Spawning habitat consists of rocky shoals, reefs, and shorelines with substrate consisting of large rocks and rubble (Johnson 2001). Spawning depths range from 40 feet to a few inches (Scott and Crossman 1973, Johnson 2001).

### 1.2 Justification

Native populations of lake trout are restricted to 7 water bodies in New Hampshire, though stocking success has resulted in self-sustaining populations in several other water bodies (Scarola 1987). Lake trout face several habitat and non-habitat related threats. Anthropogenic eutrophication decreases dissolved oxygen at depths where trout take refuge from summer heat (Kelso et al. 1996). Thus, the species may be an indicator for the water quality of oligotrophic lakes (Halliwell et al. 2001). A healthy population of forage fish is important for the persistence of lake trout in a given lake. The introduction of nonindig-

enous fish may alter the food web in a lake ecosystem, reducing the amount of prey available to lake trout (Pazzia et al. 2002). Lake trout were rated second and sixth, respectively, for species preference in an ice fishing and an open-water angler survey (Duda and Young 1996). Lake trout populations, especially low density, self-sustaining populations, have been found to be vulnerable to angling pressure (Towne 1959).

### 1.3 Protection and Regulatory Status

Daily harvest of lake trout is restricted to 2 fish. Seasons for lake trout fishing consist of 1 January to 31 March (ice fishing) and 1 April to 30 September (open water). Minimum length limits vary between water bodies, ranging from 15 to 18 inches. Anglers are restricted to 2 fishing devices during the open water season in all water bodies. During the ice-fishing season, 2 or 6 fishing devices are allowed, depending on the particular water body. Some lakes and ponds are managed for trout fishing and have no closed season.

### 1.4 Population and Habitat Distribution

Lake trout are widely distributed throughout northern North America, and populations are found in several oligotrophic water bodies in New Hampshire. Native populations exist in both central and northern New Hampshire (Squam Lake, Winnepesaukee Lake, Newfound Lake, First Connecticut Lake and Second Connecticut Lake). Successful stocking programs have introduced self-sustaining populations of lake trout in 17 additional water bodies, increasing their distribution to include more water bodies in the central, southwestern, and northern parts of the state. Stocking hatchery-reared lake trout was discontinued in 1981 after it was determined to have a minimal affect on angler success (Perry 1991).

## 1.5 Town Distribution Map

Maps for native and stocked populations are provided.

## 1.6 Habitat Map

A map of deep and cold lake habitat in the Connecticut and Androscoggin Headwaters (refer to the systems 5 and 7), the Western Hills (refer to systems 3 and 9), and the Lakes Region (refer to systems 10 and 14) would facilitate future surveys.

## 1.7 Sources of Information

Peer-reviewed literature, state lake trout management plans (New Hampshire and Maine), and New Hampshire Fish and Game (NHFG) stocking records were used to define distribution and habitat.

## 1.8 Extent and Quality of Data

The distribution and status of lake trout in New Hampshire have been well documented in reports by NHFG.

## 1.9 Distribution Research

The distribution of lake trout in New Hampshire is well known.

## ELEMENT 2

*Not completed for this species*

## ELEMENT 3

*Not completed for this species*

## ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

### 5.1 Literature

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Perry, S. 1991. Lake Trout (*Salvelinus namaycush*) A Revised Management Plan. New Hampshire Fish and Game Department, Concord, New Hampshire, USA.

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Towne, R. 1959. Fisheries investigations at the Squam Lakes, New Hampshire. New Hampshire Fish and Game Department. Federal Aid Project: F-6-R. 289p.

## SPECIES PROFILE

# Lake Whitefish

*Coregonus clupeaformis*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5

State Rank: S3

Author: Benjamin, J. Nugent, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Lake whitefish are a pelagic, cool water species requiring either large rivers or deep, cold, clear lakes (Scarola 1987, Scott and Crossman 1973). Lake whitefish seek the cooler waters of the hypolimnion during summer months and are occasionally found along shoals in spring (Scott and Crossman 1973). Spawning habitats consists of shallow water reefs or tributary streams with hard or rocky substrates (Scarola 1987, Scott and Crossman 1973). Spawning occurs at temperatures ranging from 40° to 50°F (Scarola 1987) at depths typically less than 25 feet (Scott and Crossman 1973). Newly hatched larvae congregate along steep shorelines and move to deeper water by early summer (Scott and Crossman 1973).

### 1.2 Justification

The lake whitefish is considered vulnerable in New Hampshire, and is believed to be limited to 6 water bodies in the state. Information about these populations is limited, though historical creel surveys and reports indicate populations with good health and high abundance (Towne 1959, Noon 1999). Current information pertaining to lake whitefish almost solely comes from occasional captures by anglers. Further studies on the population's health and status are warranted.

### 1.3 Protection and Regulatory Status

In New Hampshire, the lake whitefish is regulated by a 2 fish daily harvest limit with no length or weight restrictions. A closed season on lake whitefish is in effect from 1 October to 31 December in some water bodies. The use of whitefish as bait for cusk (*Lota lota*) is prohibited.

### 1.4 Population and Habitat Distribution

Lake whitefish are distributed throughout Canada and the northern United States. Populations in New Hampshire are at the southern extent of the species' global range (Scarola 1987). Scarola (1987) maintains lake whitefish were native to 2 New Hampshire lakes (Umbagog and Winnepesaukee lakes), whereas Gordon (1937) believes lake whitefish were introduced in the Androscoggin watershed (e.g., Umbagog Lake). Two lake whitefish, possibly stocked, were found in Umbagog Lake in 1905, and none has been found since (Basley 2001). It is currently believed that populations exist in Winnepesaukee, Big Squam, Wentworth (Scarola 1987), Winnisquam, Silver (Madison) (D. Miller, New Hampshire Fish and Game (NHFG), personal communication), First Connecticut, and Francis Lakes (M. Garabedian, NHFG, personal communication, Bailey and Oliver 1939). The species has also been reported in several other water bodies within the state through stocking programs (Newfound Lake, Island Pond (Hampstead), Ossipee Lake, Sunapee Lake, Little Squam Lake, and Second Connecticut Lake) (NHFG, unpublished data).

### 1.5 Town Distribution Map

A map is provided.

## 1.6 Habitat Map

More research will be necessary to determine the current distribution and habitat requirements of this species in New Hampshire. A map of lake habitat in the Connecticut and Androscoggin Headwaters (refer to the systems 5 and 7) and Lakes Region (refer to the systems 10 and 14) would facilitate future surveys.

## 1.7 Sources of Information

Peer-reviewed literature was used to define species' distribution and habitat. NHFG unpublished data, published literature, and personal communications with a NHFG conservation officer and fisheries biologist were used to define statewide distribution. Historical distribution data were verified through samples of lake whitefish contained in a museum database.

## 1.8 Extent and Quality of Data

Recent data for the species are scarce, with the majority of information available dating to the 1930s. Population distribution data are based on historical sampling data and recent angler reports to biologists and conservation officers. Data should be treated cautiously, for the round whitefish (*Prosopium cylindraceum*) may have been misidentified as the lake whitefish (Normandeau 1963).

## 1.9 Distribution Research

Sampling locations presumed to hold populations of lake whitefish should be prioritized (Winnepesaukee, Big Squam, Winnisquam, Silver (Madison), First Connecticut, Francis and Wentworth lakes). Attempts should also be made to sample water bodies once known or presumed to have held the species (Umbagog Lake, Island Pond, Newfound Lake, Second Connecticut Lake, Sunapee Lake, Little Squam Lake and Ossipee Lake). Confirming the distribution of lake whitefish in New Hampshire will be the first step toward assessing the population status.

## ELEMENT 2: SPECIES/HABITAT CONDITION

### 2.1 Scale

Seven polygons will be used as conservation planning units. Habitat units will consist of individual lakes believed to hold lake whitefish populations. Winnepesaukee, Big Squam, Winnisquam, Silver (Madison), First Connecticut, Francis, and Wentworth lakes are such planning units.

### 2.2 Relative Health of Populations

Abundant populations of lake whitefish were historically seen in some of New Hampshire's waterbodies. Scarola (1987) noted that anglers once eagerly targeted the lake whitefish. A creel census in 1952 and 1953 indicated lake whitefish were highly targeted by ice fishermen in the Squam lakes, with estimated annual harvest yields of 500 pounds (Towne 1959). Lake whitefish have been observed in tributaries of both First Connecticut Lake and Lake Francis, and were noted for size ("three pounds or more") and fight (M. Garabedian, NHFG, personal communication). There have been reports of recent angler catches from Silver Lake (Madison) (Don Miller, NHFG, personal communication). Populations significantly declined due to "overexploitation and abuse" (Scarola 1987). The status of the relative health of populations is not known.

### 2.3 Population Management Status

At this time, it is unlikely that the 2 fish daily harvest limit affects existing populations. A recent survey of resident and nonresident anglers indicated that the lake whitefish is very rarely, if at all, caught (Duda and Young 1996). Accounts of accidental captures of lake whitefish are rare. No other direct management effort exists at this time.

### 2.4 Relative Quality of Habitat Patches:

See Connecticut and Androscoggin Headwaters (refer to the systems 5 and 7) and Lakes Region (refer to the systems 10 and 14) habitat profiles. All seven units are classified as oligotrophic (NHDES Lakes and Ponds Inventory). Thermal stratification exists within these 6 lakes, providing necessary well-oxygenated thermal

refuges during summer months. Substrate selection appears only to be a factor during spawning periods (Bradbury et al. 1999). Tributary streams are available for spawning runs within all habitat units.

Competition for habitat and forage food exists between lake whitefish and a variety of other fish species (Hart 1931). Rainbow smelt, lake trout (*Salvelinus namaycush*), and yellow perch (*Perca flavescens*) share similar aspects of habitat and diet selection with the lake whitefish (Kerr and Grant 2000). Burbot have been documented to prey on lake whitefish populations (Lasenby et al. 2001). Winnepesaukee, Winnisquam and Big Squam lakes contain populations of rainbow smelt, lake trout, burbot, and yellow perch (Towne 1959, Gordon 1937, Bailey 1938); yellow perch have been documented in Wentworth Lake (Bailey 1938). First Connecticut Lake and Lake Francis contain populations of rainbow smelt, burbot, and lake trout (Bailey and Oliver 1939, NHFG unpublished data).

## 2.5 Habitat Patch Protection Status

See Connecticut and Androscoggin Headwaters (refer to the systems 5 and 7) and Lakes Region (refer to the systems 10 and 14) habitat profiles.

## 2.6 Habitat Management Status

Results of restoration and management of the habitat patches in relation to the lake whitefish are unknown.

## 2.7 Sources of Information

Literature reviews and personal communications with a fisheries biologist and a conservation officer were conducted to define locations of existing populations and relative condition of habitat units. Internet sources were used to identify protection status of the mapped units.

## 2.8 Extent and Quality of Data

Information describing the condition of the species is extremely limited. Current available data regarding the species should only be used to indicate where a population once existed and may still be present today. Some populations were once abundant and

highly valued by sport fishermen (Scarola 1987), but the lack of current data makes it difficult to establish the health and abundance of present populations.

## 2.9 Condition Assessment Research

Recent information on the species is very limited. Fall and early winter sampling presumed locations of the species should be of highest priority (Winnepesaukee, Big Squam, Winnisquam, Silver (Madison), First Connecticut, Francis and Wentworth lakes). Sampling of spawning adults over multiple years will reveal trends in population abundance. Length, weight, sex ratio, and fecundity data can be used to assess the condition, growth rates, and potential yield of the lake whitefish in each water body. Observations can be made at the spawning locations to identify possible predators affecting recruitment success. Information obtained from sampling will determine the scope of action needed to protect the species.

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

### 5.1 Literature cited

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## 5.2 Data Sources

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2003. New Hampshire Lakes and Ponds Inventory. Volume XIX NHDES.
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## SPECIES PROFILE

# Northern Redbelly Dace

*Phoxinus eos*

**Federal Listing:** Not listed

**State Listing:** Not listed

**Global Rank:** G5

**State Rank:** S3

**Author:** Benjamin, J. Nugent, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

The northern redbelly dace inhabits acidic lakes, ponds, and backwater streams in areas with minimal water velocity. Spawning occurs in algae masses within these habitats (Scarola 1987). Spawning times range from May to August and are dependent on latitude and local environment (Scott and Crossman 1973).

### 1.2 Justification

The species is considered vulnerable in New Hampshire (NatureServe 2005) and appears to be limited to 2 regions of the state. Water flow alteration, sedimentation, and erosion may severely effect northern redbelly dace populations within New Hampshire (Massachusetts Division of Fisheries and Wildlife 2003). There is little information available on the status of northern redbelly dace in New Hampshire.

### 1.3 Protection and Regulatory Status

No specific protection for this species. Species may be used for live bait.

### 1.4 Population and Habitat Distribution

Populations in New Hampshire occupy the southeastern corner of the global range of northern redbelly

dace (Scarola 1987). The New Hampshire population of northern redbelly dace appears to be concentrated within the northern region of the state. Populations of northern redbelly dace exist throughout the upper Connecticut River and Androscoggin River watersheds. The species is known to be present in the Sugar River watershed south of the White Mountains of New Hampshire (Gordon 1937, Bailey and Oliver 1939, Scarola 1987, NHFG unpublished data).

### 1.5 Town Distribution Map

Within the last 20 years, redbelly dace have been observed in Clarksville, Columbia, Newport, and Pittsburg; before then, they were observed in Berlin, Claremont, Clarksville, Colebrook, Columbia, Lancaster, and Pittsburg.

### 1.6 Habitat Map

More research will be necessary to determine the current distribution and habitat requirements of this species in New Hampshire. A map of pond, stream, and lake habitat in the Connecticut and Androscoggin Headwaters (refer to the systems 5 and 7) and the Western Hills (refer to systems 3 and 9) would help target future survey work.

### 1.7 Sources of Information

Published literature was used to define the global distribution and habitat requirements of northern redbelly dace. New Hampshire Fish and Game (NHFG) unpublished data, New Hampshire Department of Environmental Services (NHDES) Biomonitoring data, and biological surveys by the NHFG from 1937 to 1939 were used to identify known populations of northern redbelly dace within the state. Historical distribution information was confirmed using sam-

ples contained in a museum database (University of Michigan Museum of Zoology 2005).

### 1.8 Extent and Quality of Data

There are very few records of redbelly dace in New Hampshire. It is not known whether the paucity of records is due to low population levels or to the lack of surveys targeting the species. Data on the species are qualitative and insufficient to identify population trends over time. Records should be treated cautiously, for the northern redbelly dace is very similar in appearance to the finescale dace (*Phoxinus neogaeus*), which may lead to misidentification (Dianne Emerson, NHFG, personal communication).

### 1.9 Distribution Research

Distribution data for the redbelly dace in New Hampshire need to be obtained. Resurveying historical sample sites may reveal changes in distribution that have occurred since past surveys. Surveying additional waters within the watersheds of the Androscoggin and upper Connecticut rivers would provide more conclusive information on the statewide distribution of the redbelly dace. Studies of the factors that limit the distribution and abundance of the species would also aid in choosing survey sites.

Because hybrids of redbelly dace and finescale dace have been found in New Hampshire (Bailey and Oliver 1939, Goddard et al. 1998), a study of the effects of hybridization on the distribution and abundance of the 2 species is also warranted. A better effort should be made to record observations of redbelly dace, as well as other nongame fish, during surveys that target other species. Records of redbelly dace should be entered into a GIS database as part of an effort to track the distribution and status of all New Hampshire fish species.

### ELEMENT 2

*Not completed for this species*

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

### 5.1 Literature

- Bailey, J., and J. Oliver. 1939. The Fishes of the Connecticut Watershed. In: A Biological Survey of the Connecticut Watershed. New Hampshire Fish and Game Department, Survey Report No. 4:150-189.
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### 5.2 Data Sources:

- Biomonitoring Program. 1995-2005. New Hampshire Department of Environmental Services, Watershed Management Bureau. <<http://www.des.state.nh.us/wmb/biomonitoring/sites/index.html>> (Accessed 2004 Dec 12).
- University of Michigan Museum of Zoology (UMMZ). 2005. Fish Collection Search. <http://141.211.243.52/UMMZ/>. (Accessed: 2005 Jan 3).

## SPECIES PROFILE

# Rainbow Smelt

*Osmerus mordax*

**Federal Listing:** Not listed

**State Listing:** Not listed

**Global Rank:** G5

**State Rank:** G5

**Author:** Matthew, A. Carpenter, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Marine smelt concentrate in estuaries and harbors. Coastal smelt populations move into rivers shortly after the break up of ice to spawn at the head of tide. During spawning they seek out gravel substrate with swift current (Scarola 1987). Freshwater smelt populations are mainly found in deep, cold, clear lakes. Some freshwater populations are found in unstratified warm-water ponds. Landlocked populations will spawn up tributary rivers of lakes and ponds or along lakeshores with sand, gravel, or fallen leaves (Scarola 1987).

### 1.2 Justification

Rainbow smelt populations are important forage bases for several marine and freshwater fishes as well as for a variety of bird species (Scarola 1987, National Marine Fisheries Service (NMFS) 2004). Barriers, sedimentation, and water quality degradation can affect smelt recruitment success (NMFS 2004). Recent data suggest rainbow smelt populations are declining in the Great Bay system and other waterbodies of New Hampshire (NHFG 2004, John Viar, NHFG, personal communication).

### 1.3 Protection and Regulatory Status

A fishing license is required for the taking of rainbow smelt inland of Memorial Bridge in Newington-

Portsmouth. There is a daily limit of 10 liquid quarts with heads and tails intact. Handheld bow nets and dip nets may be used on the Oyster, Squamscott, Bel-lamy, and Lamprey Rivers between 16 December and 28 February. Nets and weirs are prohibited from 1 March to 15 December inland of Memorial Bridge.

Two different methods can be used to take freshwater smelt. Both methods (angling and dip netting) have a daily limit of 2 liquid quarts. Angling seasons for rainbow smelt vary by waterbody management type. A limited number of waterbodies are open to dip net fishing. The season for taking smelt with a dip net is between 15 March and 30 April between sunset and midnight.

### 1.4 Population and Habitat Distribution

Rainbow smelt are found along the coast of North America in both the north Atlantic and the north Pacific Oceans (Scarola 1987). Great Bay, and the rivers that flow into it, are important spawning areas and nursery habitat for coastal smelt populations. Native landlocked populations are believed to exist in Winnepesaukee, Winnisquam, and Squam lakes (Scarola 1987). Several other waterbodies throughout New Hampshire are believed to contain introduced smelt populations. As many as 105 waterbodies currently have or once held smelt populations (NHFG unpublished data).

### 1.5 Town Distribution Map

Maps for native and stocked freshwater smelt populations are provided.

### 1.6 Habitat Map

Anadromous rainbow smelt inhabit rivers, harbors, and estuaries of southeastern of New Hampshire.

See the Tidal Coastal Watersheds profile (system 13). Freshwater landlocked populations of rainbow smelt are residents in several lakes and ponds scattered throughout New Hampshire. See the Northern Upland Watersheds (systems 5 and 7), Mainstem Watersheds (systems 1 and 2), Southern Upland Watersheds (systems 3 and 9), Montane Watersheds (systems 4, 6, and 8), Coastal Transitional Watersheds (systems 10 and 14), and Non-Tidal Coastal Watersheds (systems 11 and 12) profiles.

### 1.7 Sources of Information

Published literature, a rainbow smelt profile from the National Marine Fisheries Service, and NHFG unpublished data were used to determine distribution and habitat requirements of the species.

### 1.8 Extent and Quality of Data

Distribution of rainbow smelt is well known but the population status is not. Ice-angling creel and egg deposition surveys would provide a good measure of relative abundance over time.

### 1.9 Distribution Research

- Determine the presence or absence of rainbow smelt populations that are not already monitored
- Monitor known populations of anadromous and landlocked populations for trend data
- Identify factors that may limit the spawning productivity of smelt populations within coastal watersheds

#### ELEMENT 2

*Not completed for this species*

#### ELEMENT 3

*Not completed for this species*

#### ELEMENT 4

*Not completed for this species*

#### ELEMENT 5: REFERENCES

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## SPECIES PROFILE

# Redfin Pickerel

*Esox americanus americanus*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5T5

State Rank: S4

Author: Benjamin, J. Nugent, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Redfin pickerel inhabit slow-moving, acidic, tea-colored streams with dense vegetation. The species is commonly found within brush piles or beneath overhanging vegetation (Scarola 1987, Fishbase 2005). Redfin pickerel also have been observed in brackish waters and swampy areas with low dissolved oxygen levels (Steiner 2004). Spawning occurs in shallow flood margins of stream habitats with thick vegetation. Redfin pickerel spawn mainly in the early spring, but there is some indication of spawning in the fall (Scott and Crossman 1973, Scarola 1987). Wintering habitat is often associated with leaf litter (Fishbase 2005).

### 1.2 Justification

Scarce data on this species may indicate low population levels. Redfin pickerel appear to be restricted to southeastern New Hampshire, and rapid urbanization in this region makes the species susceptible to poor water quality and other habitat related threats (Richter et al. 1997). The introduction of other *Esox* species into aquatic systems with low redfin pickerel populations may compromise the genetic identity of the species. Kramer (2002) recognizes the importance of the redfin pickerel as a top-level predator in certain aquatic communities.

### 1.3 Protection and Regulatory Status

There are no specific protection or regulations for this species.

### 1.4 Population and Habitat Distribution

The redfin pickerel inhabits watersheds in the Atlantic coastal plain of the eastern United States and southeastern Canada (Scarola 1987). All evidence suggests that the species occurs exclusively in the coastal and lower Merrimack watersheds within New Hampshire (Gordon 1937, Bailey 1938, New Hampshire Fish and Game (NHFG) unpublished data, New Hampshire Department of Environmental Services (NHDES) Biomonitoring data).

### 1.5 Town Distribution Map

A map is provided.

### 1.6 Habitat Map

More research will be necessary to determine the current distribution and habitat requirements of this species in New Hampshire. A map of low gradient streams and pond habitat in the coastal watersheds (refer to the system 13) and the Merrimack watersheds (System 11 and system 12) would facilitate future surveys.

### 1.7 Sources of Information

Published literature provided information on distribution and habitat requirements. NHFG unpublished data, NHDES Biomonitoring data, and watershed biological surveys conducted by NHFG from 1937 to 1939 were used in defining population locations of the species within New Hampshire.

## 1.8 Extent and Quality of Data

Data on the distribution of the redfin pickerel in New Hampshire were collected in other studies and monitoring projects. No surveys have been conducted that specifically target redfin pickerel or their habitat. The NHDES Biomonitoring program provides the most recent information on the presence of redfin pickerel at certain sampling sites in southeastern New Hampshire. All records of redfin pickerel should be viewed with caution because the species is easily mistaken for a juvenile chain pickerel (Scarola 1987).

## 1.9 Distribution Research

Distribution data for redfin pickerel in New Hampshire should be obtained. The NHDES Biomonitoring data could be used to guide future sampling efforts to establish the range of the species. Studies of factors that limit the distribution and abundance of redfin pickerel would be helpful. Habitat data collected from sites with known populations may be used to identify new survey sites. Data should be entered into a GIS database to help identify variables that may predict the presence of redfin pickerel and to track the distribution of the species over time.

### ELEMENT 2

*Not completed for this species*

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

### 5.1 Literature

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Steiner L. 2004. Pennsylvania Fishes. [http://sites.state.pa.us/PA\\_Exec/Fish\\_Boat/pafish/fishhtmls/chap14.htm](http://sites.state.pa.us/PA_Exec/Fish_Boat/pafish/fishhtmls/chap14.htm) (Accessed 2005 Feb 8)

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Fishbase. 2005. Redfin pickerel species summary page. < [www.fishbase.se/Summary/SpeciesSummary.cfm?genusname=Esox&speciesname=americanus%20americanus](http://www.fishbase.se/Summary/SpeciesSummary.cfm?genusname=Esox&speciesname=americanus%20americanus)>. Accessed 2005 Dec.

## SPECIES PROFILE

# Round Whitefish

*Prosopium cylindraceum*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5

State Rank: S3

Author: Benjamin, J. Nugent, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Round whitefish inhabit deep, clear, cold water lakes and their tributaries (Scarola 1987). The species prefers relatively shallow water, rarely exceeding depths of 150 feet (Scott and Crossman 1973). Spawning occurs in lake shallows, reefs, and river mouths with gravelly or rocky substrate when surface temperatures reach 40°F. Peak spawning activity occurs during the second week of December in Newfound Lake (Scott and Crossman 1973, Normandeau 1963). Round whitefish in Newfound Lake were observed to spawn on the same reef as lake trout (*Salvelinus namaycush*) (Normandeau 1963). Information concerning habitat use of juvenile round whitefish is unavailable.

### 1.2 Justification

The round whitefish is considered vulnerable in New Hampshire because it is believed to be limited to 3 waterbodies. Although an intense study was conducted on one of the populations (Newfound Lake, Normandeau 1961-1962), no contemporary information about these populations is available. Bouton and Stegemann (1993) have identified tapeworms, over harvest, spawning habitat degradation, siltation, acidification, and predation by yellow perch as threats to round whitefish in New York. Further studies in New Hampshire are warranted to develop a better knowledge of the population's health and status.

### 1.3 Protection and Regulatory Status

In New Hampshire, the round whitefish is regulated by a 2 fish daily harvest limit with no length or weight restrictions. A closed season on round whitefish is in effect from 1 October to 31 December in some water bodies. The use of whitefish as bait for burbot (*Lota lota*) is prohibited (RSA 211).

### 1.4 Population and Habitat Distribution

The distribution of the round whitefish is circumpolar, with New Hampshire's population at the southern most part of its range. Round whitefish historically existed in Newfound, First Connecticut, and Winnepesaukee Lakes, as well as the upper Connecticut River (Scarola 1987, Bailey and Oliver 1939). Current populations of the species are believed to exist in both Winnepesaukee and Newfound lakes (Scarola 1987). The status of current Connecticut River and First Connecticut Lake populations is unknown. A population of round whitefish may be present in Lake Francis. Bailey and Oliver (1939) observed round whitefish in the upper Connecticut River, possibly in the area where Lake Francis was later created by impoundment. In 1995, there was an unverified sighting of the species in the upper Connecticut River in the town of Colebrook or Columbia (Scott Decker, New Hampshire Fish and Game (NHFG), personal communication).

### 1.5 Town Distribution Map

A map is provided.

### 1.6 Habitat Map

More research will be necessary to determine the distribution and habitat requirements of this species in

New Hampshire. A map of river and lake habitat in the Connecticut and Androscoggin Headwaters (refer to the systems 5 and 7), the Western Hills (refer to the systems 3 and 9) and the Lakes Region (refer to the systems 10 and 14) would facilitate future surveys.

## 1.7 Sources of Information

New Hampshire Fish and Game unpublished data, historical watershed biological surveys, and an angler report were used in defining locations of the species within the state. Historical distribution data were confirmed using samples contained in a museum database.

## 1.8 Extent and Quality of Data

Recent sampling data are very limited. Although literature from Normandeau (1963) provides detailed information on the round whitefish of Newfound Lake, no direct monitoring for the species has been conducted in other water bodies. The existence of round whitefish in Newfound and Winnepesaukee Lakes has been verified by recent angler catches and the discovery of mortalities. Data should be treated cautiously, for the lake whitefish (*Coregonus clupeaformis*) may have been misidentified as the round whitefish (Normandeau, 1963).

## 1.9 Distribution Research

Recent information on the species is very limited. Sampling presumed locations of the round whitefish should be a priority. Confirming the distribution of the round whitefish in the state will be the first step toward assessing the status of the species. Information obtained from sampling will determine the scope of action needed to protect New Hampshire's round whitefish populations.

## ELEMENT 2: SPECIES/HABITAT CONDITION

### 2.1 Scale

Habitat units are based on known populations, historic populations, and areas that potentially hold populations of round whitefish. Newfound Lake, Winnepesaukee Lake, First Connecticut Lake, and Lake Francis are thought to have historic, current

or potential round whitefish populations. The upper Connecticut River will also be included because of the likelihood of a population. Newfound and Winnepesaukee Lakes are mapped as individual units. The upper Connecticut River (HUC10) watershed map unit contains First Connecticut Lake and Lake Francis.

### 2.2 Relative Health of Populations

Current populations trends in all units are unknown. Normandeau (1963) acknowledged the Newfound Lake population of round whitefish as abundant and healthy. In 2001, fisheries biologists observed one round whitefish during fall netting on Newfound Lake, and an angler harvested a new state record round whitefish (457mm, 785g) from Newfound Lake in the winter of 2005. Other round whitefish catches have been reported from Newfound in 2005 (John Viar, NHFG personal communication). The historic population of round whitefish in First Connecticut Lake was also reported to be plentiful (Bailey and Oliver 1939). No historic information about population abundance is available for other units.

### 2.3 Population Management Status

It is unlikely that the 2 fish daily harvest limit affects populations. A recent survey of anglers indicated that the round whitefish is very rarely, if at all, caught (Duda and Young 1996). Angling pressure is believed to have little effect on round whitefish populations within the state (Normandeau 1963). No other direct ongoing management effort exists at this time.

### 2.4 Relative Quality of Habitat Patches

Refer to the Connecticut and Androscoggin Headwaters (refer to the systems 5 and 7), the Western Hills (refer to the systems 3 and 9) and the Lakes Region (refer to the systems 10 and 14) habitat profiles.

Distinct habitat requirements of round whitefish are not well understood. Normandeau (1963) determined that spawning round whitefish in Newfound Lake used the same reef as spawning lake trout. Monitoring studies on the upper Connecticut River indicate adequate amounts of dissolved oxygen, low levels of embedded, fine particles or organic matter, and a variety of fish habitat (Francis and Mulligan

1997). Sedimentation and turbidity are identified as the 2 highest threats to the upper Connecticut River (Francis and Mulligan 1997). Silviculture practices have catalyzed bank erosion rates, introducing sediments and nutrients into the system. High water temperatures in the summer months, coupled with excessive nutrient levels can significantly lower dissolved oxygen rates. The Connecticut Lakes have rocky shorelines, which is the potential spawning substrate for round whitefish.

## 2.5 Habitat Patch Protection Status

Refer to the Connecticut and Androscoggin Headwaters (refer to the Systems 5 and 7), the Western Hills (refer to the systems 3 and 9) and the Lakes Region (refer to the systems 10 and 14) habitat profiles.

## 2.6 Habitat Management Status

Results of restoration and management of the habitat patches in relation to the round whitefish are unknown.

## 2.7 Sources of Information

Literature reviews were conducted to define key components required for habitats, as well as the historical abundances of populations. Internet sources were used to define current quality and management of specific habitat patches.

## 2.8 Extent and Quality of Data

Current available data regarding the species should only be used to indicate where a population once existed and may still be present today. Historically, 2 populations were defined as abundant and healthy (Bailey and Oliver 1939, Normandeau 1963), but the lack of current data makes it difficult to establish the health and abundance of present populations.

## 2.9 Condition Assessment Research

Recent information of the species is very limited. Sampling presumed locations of the species should be a priority (The upper Connecticut River and Winnepesaukee, Newfound, First Connecticut, and Francis lakes). Length and weight data will be used to define

condition indices, and age data and male/female ratios will help define growth rates and recruitment potential. Information obtained from sampling will determine the scope of action needed to protect the species.

## ELEMENT 3

*Not completed for this species*

## ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

### 5.1 Literature

- Bailey, J., and J. Oliver. 1939. The Fishes of the Connecticut Watershed. In: A Biological Survey of the Connecticut Watershed. New Hampshire Fish and Game Dept., Survey Report No. 4:150-189.
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- The Connecticut River. <<http://www.des.state.nh.us/rivers/conn1.htm>>. Accessed 2005.
- Duda, M., and K. Young. 1996. New Hampshire Freshwater Angler Survey. New Hampshire Fish and Game Department, Concord, New Hampshire, USA.
- Francis, S., and A. Mulligan. 1997. Connecticut River Corridor Management Plan. <[http://Francis and Mulligan 1997/corridor-plan/plan-TOC.html](http://Francis%20and%20Mulligan%201997/corridor-plan/plan-TOC.html)>. Accessed 2005 Jan.
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- Scott, W., and E. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada. 966p.
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Volunteer Lake Assessment Program. 2003 Mar 26. <<http://www.des.state.nh.us/wmb/vlap/how.htm>>. Accessed 2005.

## 5.2 Data Sources

UMMZ Fish Collection Search. <http://141.211.243.52/UMMZ/>. (Accessed: 2005 February 7).

NatureServe. 2005. NatureServe Explorer: An online encyclopedia of life [web application]. Version 4.2. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>. (Accessed: January 24, 2005).

## SPECIES PROFILE

# Sea Lamprey

*Petromyzon marinus*

Federal Listing: Not listed  
State Listing: Not listed  
Global Rank: G5  
State Rank: S4  
Author: Matthew A. Carpenter, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Sea lampreys spend their adult lives in the ocean as a parasite on other fish. After 20 to 30 months at sea they migrate into freshwater, following pheromones from larvae (ammocoetes) upstream (Vrieze and Sorenson 2001). Sea lampreys construct nests in gravel/cobble riffle sections of freshwater streams (Scarola 1987). Once hatched, the larvae float downstream to slow moving pools where they burrow into the substrate and filter feed on organic detritus drifting in the water column (Scarola 1987).

### 1.2 Justification

Sea lampreys are blocked from much of their spawning habitat by dams, and in New Hampshire depend on fishways to reach spawning habitat. Although Atlantic coastal populations are not currently endangered, there have been significant declines in lamprey populations throughout the northern hemisphere (Renaud 1997). A complex life cycle, which is dependent on multiple habitats in freshwater and marine ecosystems, makes the sea lamprey vulnerable to the effects of urbanization in coastal watersheds (Creel 2003).

### 1.3 Protection and Regulatory Status

A permit is required to collect lampreys for research.

### 1.4 Population and Habitat Distribution

The sea lamprey is native to rivers from Florida to Nova Scotia in the West Atlantic, and from Western Europe to northern Africa in the east Atlantic. In New Hampshire, sea lampreys are restricted to rivers with actively managed fish ladders. During the spring spawning runs of river herring and American shad, lampreys use the Connecticut River, Merrimack River, and coastal rivers (Scarola 1987).

### 1.5 Town Distribution Map

*Not completed for this species*

### 1.6 Habitat Map

Sea lampreys inhabit the lower section of the Merrimack River and the coastal watersheds of New Hampshire. See the Non-Tidal Coastal Watersheds (systems 11 and 12), Mainstem Watersheds (systems 1 and 2), and Tidal Coastal Watersheds (system 13) profiles.

### 1.7 Sources of Information

Sea lamprey numbers are recorded during the monitoring programs for other fish. (eels are catadromous)

### 1.8 Extent and Quality of Data

Data on sea lamprey returns are often incidental to data collected on the spawning runs of other fish.

### 1.9 Distribution Research

The actual locations of sea lamprey spawning habitat and ammocoete habitat within New Hampshire watersheds are unknown.

**ELEMENT 2**

*Not completed for this species*

**ELEMENT 3**

*Not completed for this species*

**ELEMENT 4**

*Not completed for this species*

**ELEMENT 5: REFERENCES**

- Creel, L. 2003. Ripple Effects: Population and Coastal Regions (Washington, D.C.: Population Reference Bureau)
- Renaud, C.B. 1997. Conservation status of Northern Hemisphere lampreys (Petromyzontidae). *Journal of Applied Ichthyology* 13(3):143-148.
- Scarola, J. 1987. *Freshwater Fishes of New Hampshire* (2<sup>nd</sup> Edition). New Hampshire Fish and Game Department, Concord, New Hampshire, USA.
- Vrieze, L.A., and P.W. Sorensen. 2001. Laboratory assessment of the role of a larval pheromone and natural stream odor in spawning stream localization by migratory sea lamprey. *Canadian Journal of Fisheries and Aquatic Science* 58:2374-2385.

## SPECIES PROFILE

# Shortnose Sturgeon

*Acipenser brevirostrum*

Federal Listing: Endangered  
State Listing: Endangered  
Affected Species: N/A  
Global Rank: G3  
State Rank: SH  
Author: Benjamin, J. Nugent, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

Shortnose sturgeons occupy freshwater rivers but occasionally enter saltwater. They prefer areas of a river with curves or bends and a sand or cobble substrate (Kynard et al. 2000). Adults return to specific parent streams to spawn (Scott and Crossman 1973). Spawning substrates consist of boulder, cobble, and gravel with water depths of 10 m or less. Water temperatures during spawning range from 9.0 to 18.0°C. Spawning runs were observed during late April in the Merrimack River, Massachusetts (Kieffer and Kynard 1996).

### 1.2 Justification

Shortnose sturgeon are federally listed as endangered and presumed extirpated in New Hampshire. They have not been observed in New Hampshire since 1971 (Doug Grout, NHFG, personal communication). Population declines due to the development of barriers (such as dams) in coastal rivers, alteration of spawning habitat, and commercial harvest have been documented (Friedland 2000). There is limited knowledge of the life stages or behavior of this species.

### 1.3 Protection and Regulatory Status

The possession of sturgeon is prohibited in New Hampshire.

### 1.4 Population and Habitat Distribution

Global distribution consists of populations along the eastern seaboard of North America (Scott and Crossman 1973). It is unclear whether populations within the Connecticut and Merrimack rivers once reached New Hampshire waters. It is believed that historic Connecticut River populations were obstructed at Turner Falls in Massachusetts (M. Kieffer, United States Geological Survey (USGS), personal communication). Historical populations within the Merrimack River were never distinguished from Atlantic sturgeon prior to dam construction (M. Kieffer, USGS, personal communication). A fish elevator at the Essex Dam (river km 46) on the Merrimack River in Massachusetts has never recorded sturgeon use. Given that shortnose sturgeon will migrate 200 km up rivers to spawn, it is likely that the species once inhabited the Merrimack River in New Hampshire (M. Kieffer, USGS, personal communication).

### 1.5 Town Distribution Map

*Not completed for this species*

### 1.6 Habitat Map

Shortnose sturgeon may once have inhabited the lower section of the Merrimack River and the coastal watershed of New Hampshire. See the Non-Tidal Coastal Watersheds (systems 11 and 12) and Tidal Coastal Watersheds (system 13) profiles.

### 1.7 Sources of Information

Published literature was used to define global range and characteristics of habitat used in freshwater. Historical distribution of the species was also obtained from published literature. Fisheries professionals provided information on current populations.

## 1.8 Extent and Quality of Data

Data are limited to 2 confirmed observations. Historical distribution information should be treated cautiously because there was often no distinction between Atlantic sturgeon and shortnose sturgeon (M. Kieffer, USGS, personal communication).

## 1.9 Distribution Research

Habitat assessments of the coastal rivers may reveal areas of potential spawning habitat. Results from these habitat assessments may identify barriers or other features that prevent the species from reaching desired spawning and foraging grounds.

### ELEMENT 2

*Not completed for this species*

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

- Bigelow, H., and W. Schroeder. 1953. Fishes of the Gulf of Maine. Fishery Bulletin of the Fish and Wildlife Service. Number 74, Volume 53.
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- Kynard, B., M. Horgan, M. Kieffer, and D. Seibel. 2000. Habitats used by shortnose sturgeon in two Massachusetts rivers, with notes on estuarine Atlantic sturgeon: a hierarchical approach. Transactions of the American Fisheries Society 129:487-503.
- Scott, W., and E. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada. 966p.

## SPECIES PROFILE

# Slimy Sculpin

*Cottus cognatus*

Federal Listing: Not listed  
State Listing: Not listed  
Global Rank: G5  
State Rank: S4S5  
Author: Benjamin, J. Nugent, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

The slimy sculpin is found in cool streams and cold deep lakes with rock and gravel substrates. The species is commonly found under rocks in both rivers and lakes. Slimy sculpin often share stream habitat with eastern brook trout (*Salvelinus fontinalis*) (Scarola 1987). They spawn in the spring when temperatures reach from 40 to 50°F in lake and river environments (Scott and Crossman 1973). The undersides of logs and large rocks are used for egg placement during spawning (Kaesler and Sharpe 2001).

### 1.2 Justification

Slimy sculpin is one of 3 New Hampshire fish species that serve as hosts to the federally and state endangered dwarf wedgemussel (*Alasmidonta heterodon*) (Nedeau et al. 2000, B. Wicklow, Saint Anselm College, personal communication). Healthy populations of slimy sculpin in the Connecticut and Ashuelot Rivers likely contribute to the persistence of dwarf wedgemussel populations in New Hampshire. The tessellated darter (*Etheostoma olmstedii*) and Atlantic salmon (*Salmo salar*) are the only other New Hampshire fish species that are hosts for the dwarf wedgemussel (Nedeau et al. 2000), and the disappearance of a self-sustaining Atlantic salmon population from the Connecticut River watershed has increased the importance of slimy sculpin as a host species. Data

on the distribution and health of slimy sculpin populations are needed to further protect the dwarf wedgemussel. The slimy sculpin is an indicator of the biological integrity of coldwater streams (Langdon 2001, Gray et al. 2004).

### 1.3 Protection and Regulatory Status

There is no specific protection of this species at the state, regional, or federal level.

### 1.4 Population and Habitat Distribution

The species is found throughout northern North America, and in New Hampshire is found in all major watersheds except the coastal watersheds (Scarola 1987). Slimy sculpin populations are more common in central and northern New Hampshire.

### 1.5 Town Distribution Map

A map is provided.

### 1.6 Habitat Map

A map of pond, stream, and lake habitat in the Connecticut and Androscoggin Headwaters (systems 5 and 7), Connecticut River (systems 1 and 2), Western Hills (systems 3 and 9), White Mountains (systems 4, 6, and 8), Lakes Region (systems 10 and 14), and Merrimack River (systems 11 and 12) would facilitate future surveys.

### 1.7 Sources of Information

Published literature, New Hampshire Fish and Game (NHFG) unpublished data, New Hampshire Department of Environmental Services (NHDES) Biomonitoring data, and historic watershed surveys were used

to describe distribution and habitat.

### 1.8 Extent and Quality of Data

Slimy sculpin are inadvertently sampled during trout and salmon surveys. Most data are qualitative and insufficient to assess population trends. Surveys verify that the species is present in streams throughout central and northern New Hampshire and absent in the coastal watershed.

### 1.9 Distribution Research

Monitoring efforts should identify areas where slimy sculpin and dwarf wedgemussels co-occur. Because the slimy sculpin is an indicator of quality coldwater stream habitat, a map of the species' distribution would provide baseline information on the status of coldwater streams in New Hampshire. A better effort should be made to document slimy sculpin during surveys intended for other species. Records should be entered into a central database to monitor the distribution and status of New Hampshire fish species. Resurveying historic sample sites may show changes in slimy sculpin distribution and possibly identify streams in need of restoration.

#### ELEMENT 2

*Not completed for this species*

#### ELEMENT 3

*Not completed for this species*

#### ELEMENT 4

*Not completed for this species*

### ELEMENT 5: REFERENCES

#### 5.1 Literature

Gray, M.A., R.A. Cunjak, and K.R. Munkittrick. 2004. Site fidelity of slimy sculpin (*Cottus cognatus*): insights from stable carbon and nitrogen analysis. Canadian Journal Fish and Aquatic Science 61:1717-1722.

Kaesler, A., and W. Sharpe. 2001. The influence of acid runoff episodes on slimy sculpin reproduction in Stone Run. Transactions of the American Fisheries Society 130:1106-1115.

Langdon, R.W. 2001. A preliminary index of biological integrity for fish assemblages of coldwater streams in Vermont. Northeastern Naturalist 8(2): 219-232.

Nedea, E.J., M.A. McCollough, and B.I. Swartz. 2000. The Freshwater Mussels of Maine. Maine Department of Inland Fisheries and Wildlife, Augusta, Maine, USA.

Scarola, J. 1987. Freshwater Fishes of New Hampshire (2<sup>nd</sup> edition). New Hampshire Fish and Game Department, Concord, New Hampshire, USA.

Scott, W., and E. Crossman. 1973. Freshwater Fishes of Canada. Fisheries Research Board of Canada. 966p.

#### 5.2 Data Sources

Biomonitoring Program. 1995-2005. New Hampshire Department of Environmental Services, Watershed Management Bureau. < <http://www.des.state.nh.us/wmb/biomonitoring/sites/index.html> >. Accessed 2004 December 12

## SPECIES PROFILE

# Sunapee Trout

*Salvelinus aureolus*

Federal Listing: Not listed  
State Listing: Endangered  
Affected Species: N/A  
Global Rank: G5  
State Rank: SX  
Author: Benjamin, J. Nugent, NHFG

(*S. namaycush*) and landlocked salmon (*Salmo salar*) (Newell 1958, Balon 1980, Scarola 1987).

### 1.3 Protection and Regulatory Status

This species is not specifically protected.

### 1.4 Population and Habitat Distribution

#### ELEMENT 1: DISTRIBUTION AND HABITAT

##### 1.1 Habitat Description

Sunapee trout inhabited a limited number of oligotrophic, deep-water lakes in New Hampshire. They were restricted to deep, cool waters during warmer months (Balon 1980), and were found throughout the water column when temperatures were below 10°C. Spawning habitat consisted of off-shore reefs with rubble, boulder, and gravel substrates. Depths of spawning sites ranged from a few inches to 20 feet (Newell 1958). Eggs hatched in late winter with ice cover still present. Upon yolk sac absorption, fry moved to deeper water to feed on zooplankton (Balon 1980).

##### 1.2 Justification

New Hampshire Fish and Game (NHFG) considers the Sunapee trout extirpated from the state because it has not been observed since the late 1970s (John Viar, NHFG, personal communication, NHFG unpublished data). Only 2 native populations occurred in New Hampshire (Scarola 1987), and attempts to introduce the species into other water bodies in New Hampshire were unsuccessful (Scarola 1987, John Viar, NHFG, personal communication). The species was vulnerable because it had a limited distribution and it was susceptible to predation and competition by other introduced fish species, especially lake trout

The phylogeny of Sunapee trout is unclear. It is likely that the Sunapee trout belonged to the Laurentian lineage of landlocked arctic char, which were trapped in northeastern lakes after the Wisconsin glaciation (Bernatchez et al. 2002). Isolated populations developed unique genetic characteristics as they adapted to local conditions (Bernatchez et al. 2002). One exception may be the now extinct silver trout, once found in Dublin Pond of New Hampshire, which may have been a subspecies of brook trout (*Salvelinus fontinalis*) or possibly even a separate species (Nelson et al. 2004). Unfortunately, due to the scarcity of preserved specimens, there may be no way to confirm the taxonomic classification of extirpated populations.

In New Hampshire, Sunapee trout existed in Sunapee Lake and Big Dan Hole Pond (Scarola 1987), though the source of these populations is not known. Attempts to introduce Sunapee trout into at least 5 other water bodies (Sawyer Pond, Penacook Lake, Third Connecticut Lake, Tewksbury Pond, and Connor Pond) were unsuccessful (Scarola 1987). No confirmed observations of the species have occurred in Sunapee Lake since the late 1960s. Unsuccessful introductions into Tewksbury Pond occurred until the mid 1970s (John Viar, NHFG, personal communication, NHFG unpublished data). The last reported stocking attempt occurred at Penacook Lake in 1977, and no samples of Sunapee trout were observed during a survey the following year (NHFG unpublished data). In 1925, 4 water bodies in Idaho

were stocked with Sunapee trout from Sunapee Lake (Kircheis et al. 1995, Fuller 2000). New York and Massachusetts also received populations of Sunapee trout in attempts to increase the range of the species (Fuller 2000).

The Laurentian lineage of arctic char is still present in 12 lakes in Maine (Bernatchez et al. 2002). A native, self-sustaining population from Floods Pond (Hancock County, Maine) was introduced to 7 other water bodies in Maine. Of the 7 introductions, at least 2 were successful in creating self-sustaining populations (Frost 2001).

### 1.5 Town Distribution Map

Maps of native and stocked populations are provided.

### 1.6 Habitat Map

*Not completed for this species*

### 1.7 Sources of Information

Peer-reviewed literature and gray literature were used to describe historic distribution and habitat. Gray literature consisted of unpublished reports, stocking cards, and papers completed by NHFG staff. Fisheries biologists from New Hampshire, Vermont, and Maine confirmed the status of the population (personal communication: John Viar, Kenneth Cox, and Dennis McNeish, respectively).

### 1.8 Extent and Quality of Data

Historic locations of the species are well documented. Documentation by several authors agree that the species is extirpated from New Hampshire.

### 1.9 Distribution Research

Because Sunapee trout are believed extinct in the state, no further research on the distribution of Sunapee trout is warranted. Fisheries management for bodies of water that once held populations of Sunapee trout includes monitoring for other fish species. No recent incidental captures of the Sunapee trout have been documented in these waters.

## ELEMENT 2: SPECIES/HABITAT CONDITION

### 2.1 Scale

No conservation planning units for a possible reintroduction of the species have been identified. Part of the condition assessment research would be to identify any suitable water bodies available for reintroducing populations of Sunapee trout.

### 2.2 Relative Health of Populations

The Sunapee trout was once very prolific (Newell 1958). The species' reproductive success was compromised by hybridization, competition, and predation by lake trout and other salmonids (Balon 1980, Frost 2001). Forage food competition from landlocked salmon and lake trout was likely a major threat to Sunapee trout, and various other fish species have been observed to feed on Sunapee trout eggs after spawning (Newell 1958). An introduced population of Sunapee trout that was established in Third Connecticut Lake failed after the introduction of lake trout (Newell 1958).

### 2.3 Population Management Status

There are no ongoing population management efforts.

### 2.4 Relative Quality of Habitat Patches

Because it is believed that the species is extirpated, there are no current habitat patches.

### 2.5 Habitat Patch Protection Status

Because it is believed that the species is extirpated, there are no current habitat patches.

### 2.6 Habitat Management Status

There are no current habitat management or restoration efforts.

### 2.7 Sources of Information

Information regarding the condition of historical populations was found through literature review.

Status of populations was obtained through conversations with local fisheries professionals.

## 2.8 Extent and Quality of Data

The disappearance of Sunapee trout from state waters is well documented.

## 2.9 Condition Assessment Research

Restoration efforts will depend on a feasibility study to determine if any suitable habitat exists in New Hampshire. Restoring Sunapee would require identification of a population with similar genetic identity from another state, though the unique genetic characteristics of Sunapee trout in Sunapee Lake and Big Dan Hole Pond can never be replicated. Genetic research has already confirmed hybridization between populations of Sunapee trout and eastern brook trout (*Salvelinus fontinalis*) in Idaho, resulting in a species with a different genetic identity (Kircheis et al. 1995). Any attempt to reestablish the Sunapee trout in New Hampshire should be viewed as an effort to extend the range of a unique strain (Laurentian) of landlocked arctic char (Bernatchez et al. 2002). Sunapee trout in Floods Pond (Maine) may have the genetic characteristics most similar to former New Hampshire populations (Kircheis et al. 1995).

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

### 5.1 Literature

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- Scarola, J. 1987. Freshwater Fishes of New Hampshire (2<sup>nd</sup> edition). New Hampshire Fish and Game Department, Concord, New Hampshire, USA.

## SPECIES PROFILE

# Swamp Darter

*Etheostoma fusiforme*

Federal Listing: Not listed  
State Listing: Not listed  
Global Rank: G5  
State Rank: S3  
Author: Benjamin, J. Nugent, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

The swamp darter inhabits lakes and ponds in shallow areas of soft muddy substrate, dense vegetation, and accumulated detritus. Stream habitats include both swift and slow moving water with patches of thick vegetation (Schmidt and Whitworth 1979, Scarola 1987). Research in Connecticut streams and ponds found swamp darters to be more abundant in ponds than in streams, and stream populations were usually found near known pond populations. Spawning activity was not observed in streams, indicating that stream populations may depend on recruitment from ponds (Schmidt and Whitworth 1979). Swamp darters are dependent on vegetation for spawning (Toth et al. 1998).

### 1.2 Justification

Swamp darter populations appear to be restricted to watersheds in the southeastern corner of the state. New Hampshire is near the northern extent of the swamp darters' global range. The short life span of the swamp darter (1 to 2 years), combined with aquatic habitat degradation caused by increasing development in southeastern New Hampshire, make the species vulnerable to extirpation from state waters (Schmidt 1983). There is little information available on the distribution, abundance, or health of swamp darter populations in New Hampshire.

### 1.3 Protection and Regulatory Status

This species is not protected.

### 1.4 Population and Habitat Distribution

The species inhabits watersheds in coastal plains of the eastern United States from Maine to North Carolina (Scarola 1987). Gordon (1937) and Bailey (1938) found populations of swamp darters in both lentic and lotic environments in the lower Merrimack and coastal watersheds. Populations in these areas were later observed in the mid 1980s (NHFG unpublished data).

### 1.5 Town Distribution Map

Within the last 20 years, swamp darters have been observed in Auburn, Barrington, Durham, Lee, Manchester, Merrimack, Milford, Salem, and Windham; before then, they were observed in Chester, Madbury, Nottingham, Raymond, and Strafford.

### 1.6 Habitat Map

More research is needed to determine the distribution and habitat requirements of this species in New Hampshire. A map of low gradient streams and pond habitat in the coastal watersheds (refer to the system 13) and the Merrimack watersheds (refer to system 11 and system 12) would help target future survey work.

### 1.7 Sources of Information

Published literature and Internet sources were used to define the species' global distribution and habitat requirements. Statewide distribution data for the swamp darter were obtained from NHFG survey sites

during the mid 1980s and from historical biological surveys of the Merrimack and Coastal watersheds. Historical distribution data were confirmed using samples contained in a museum database (UMMZ Fish Collection 2005).

## 1.8 Extent and Quality of Data

Information on the current distribution of the swamp darter within the state is limited, though statewide sampling data confirm that the species is restricted to southeastern New Hampshire. However, the range of the swamp darter population within this region is not well understood. The swamp darter can be confused with the tessellated darter.

## 1.9 Distribution Research

Of 19 known swamp darter records, 12 came from biological surveys by NHFGD in the 1930s. Resurveying historical sample sites should be the first step toward assessing the status of the swamp darter population. Habitat data collected from sites with known populations may be used to identify new survey sites. Data should be entered into a GIS database to help identify variables that may predict the presence of banded sunfish and to track the distribution of the species over time.

### ELEMENT 2

*Not completed for this species*

### ELEMENT 3

*Not completed for this species*

### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

### 5.1 Literature

Bailey, R.M. 1938. The Fishes of the Merrimack Watershed. In: A Biological Survey of the Merrimack Watershed. New Hampshire Fish and Game Department, Survey Report No. 3:149-185.

Gordon, M. 1937. The Fishes of Eastern New Hampshire. In: A Biological Survey of the Androscoggin, Saco and Coastal Watersheds. New Hampshire

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Scarola, J. 1987. Freshwater Fishes of New Hampshire. New Hampshire Fish and Game Department, Concord, New Hampshire, USA.

Schmidt, R., and W. Whitworth. 1979. Distribution and habitat of the swamp darter (*Etheostoma fusiforme*) in southern New England. American Midland Naturalist 102:408-413.

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### 5.2 Data Sources

Biomonitoring Program. 1995-2005. New Hampshire Department of Environmental Services, Watershed Management Bureau. [www.des.state.nh.us/wmb/biomonitoring/sites/index.html](http://www.des.state.nh.us/wmb/biomonitoring/sites/index.html) >. Accessed 2004 December 12

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University of Michigan Museum of Zoology (UMMZ). 2005. Fish Collection Search. <<http://141.211.243.52/UMMZ/>> (Accessed: January 3, 2005).

## SPECIES PROFILE

# Tessellated Darter

*Etheostoma olmstedii*

Federal Listing: Not listed

State Listing: Not listed

Global Rank: G5

State Rank: S4

Author: Benjamin, J. Nugent, NHFG

## ELEMENT 1: DISTRIBUTION AND HABITAT

### 1.1 Habitat Description

The tessellated darter inhabits pools of warm upland streams and shallow areas in large lakes and rivers (Scarola 1987). It is usually found over mud or sand substrates (Scarola 1987). Slow to moderate flow in rivers and streams are preferred, although larger individuals may be found in rocky riffles (Schmidt 1980). Spawning occurs in the spring under an overhanging rock or log in shallows (Schmidt 1980).

### 1.2 Justification

The tessellated darter is one of 3 New Hampshire fish species that serve as hosts to the federally and state endangered dwarf wedgemussel (*Alasmidonta heterodon*) (Nedeau et al. 2000), and healthy populations of tessellated darter in the Connecticut and Ashuelot Rivers likely contribute to the persistence of dwarf wedgemussel populations in New Hampshire. The slimy sculpin (*Cottus cognatus*) and Atlantic salmon (*Salmo salar*) are the only other New Hampshire fish species that act as hosts for the dwarf wedgemussel (Nedeau et al. 2000, B. Wicklow, Saint Anselm College, personal communication). The disappearance of a self-sustaining Atlantic salmon population from the Connecticut River watershed has increased the importance of tessellated darter as a host species. A Massachusetts study suggests that the ability of dwarf wedgemussels to colonize new areas may be limited by the movements of tessellated darters (McLain and

Ross 2005). Monitoring of the distribution and health of tessellated darter populations is needed to help protect the dwarf wedgemussel.

### 1.3 Protection and Regulatory Status

There is no specific protection of this species at the state, regional, and federal levels.

### 1.4 Population and Habitat Distribution

Populations of tessellated darters are found in Atlantic drainages from the St. Lawrence River to Florida. In New Hampshire, the species had been reported to exist exclusively in the Connecticut River watershed, with no records in the extreme northern reaches (Scarola 1987). Bailey and Oliver (1939) found abundant populations of tessellated darters in the middle and lower portions of the Connecticut River and its tributaries. Tessellated darters have recently been documented in the Merrimack River watershed (NHDES Biomonitoring Program).

### 1.5 Town Distribution Map

A map is provided.

### 1.6 Habitat Map

A map of pond, stream, and lake habitat in the Connecticut and Androscoggin Headwaters (refer to the systems 5 and 7), Connecticut River (refer to the systems 1 and 2), Western Hills (refer to the systems 3 and 9), and Merrimack River (refer to the systems 10, 11, and 12) would facilitate future surveys.

### 1.7 Sources of Information

NHFG unpublished data, NHDES Biomonitoring

data, and historic watershed surveys were used to define known and potential locations of tessellated darters within the state.

### 1.8 Extent and Quality of Data

Extensive survey work by NHFG and NHDES has documented the presence of tessellated darters in certain watersheds. Data suggest that the tessellated darter is not present in the coastal and Androscoggin watersheds. However, the possible presence of the species in these watersheds cannot be ruled out. Existing data are qualitative and are insufficient to identify population trends. Tessellated darters are often misidentified as swamp darters.

### 1.9 Distribution Research

Areas of potential coincidence of tessellated darters and dwarf wedgemussels should be a priority for distribution research. Reproduction of dwarf wedgemussel depends on populations of tessellated darters, therefore, there is a great need to obtain current distribution data. Resurveying sites with historical records may show changes in tessellated darter distribution patterns. Surveying additional locations in Connecticut and Merrimack River watersheds would provide better information on the statewide distribution of the species. Studies of the factors that limit the distribution and abundance of the species would aid in choosing survey sites. A better effort should be made to record observations of tessellated darter, as well as other nongame fish, during surveys of other species. Records of tessellated darter should be entered in a central database to track the distribution and status of all New Hampshire fish species.

#### ELEMENT 2

*Not completed for this species*

#### ELEMENT 3

*Not completed for this species*

#### ELEMENT 4

*Not completed for this species*

## ELEMENT 5: REFERENCES

### 5.1 Literature

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- Bailey, R.M. 1938. The Fishes of the Merrimack Watershed. In: A Biological Survey of the Merrimack Watershed. New Hampshire Fish and Game Dept., Survey Report No. 3:149-185.
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### 5.2 Data Sources

- Biomonitoring Program. 1995-2005. New Hampshire Department of Environmental Services, Watershed Management Bureau. <<http://www.des.state.nh.us/wmb/biomonitoring/sites/index.html>>. Accessed 2004 December 12

# FISH MAPS

















